











THE ANNALS  
AND  
MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND  
CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY'.)

CONDUCTED BY

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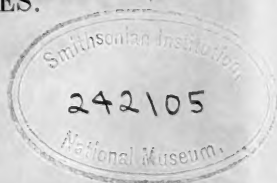
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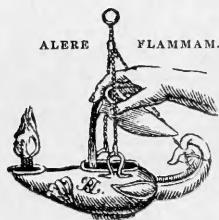


"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper æstimata; à verè eruditis et sapientibus semper exulta; malè doctis et barbaris semper inimica fuit."—LINNÆUS.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—BRUCKNER, *Théorie du Système Animal*, Leyden, 1767.

. . . . . The sylvan powers  
 Obey our summons; from their deepest dells  
 The Dryads come, and throw their garlands wild  
 And odorous branches at our feet; the Nymphs  
 That press with nimble step the mountain-thyme  
 And purple heath-flower come not empty-handed,  
 But scatter round ten thousand forms minute  
 Of velvet moss or lichen, torn from rock  
 Or rifted oak or cavern deep: the Naiads too  
 Quit their loved native stream, from whose smooth face  
 They crop the lily, and each sedge and rush  
 That drinks the rippling tide: the frozen poles,  
 Where peril waits the bold adventurer's tread,  
 The burning sands of Borneo and Cayenne,  
 All, all to us unlock their secret stores  
 And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.



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# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

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"..... per litora spargite museum,  
Naiades, et circum vitreos considite fontes:  
Pollice virgineo teneros hic carpite flores:  
Floribus et pictum, divæ, replete canistrum.  
At vos, o Nymphæ Craterides, ite sub undas;  
Ite, recurvato variata corallia trunco  
Vellite muscosis e rupibus, et mihi conchas  
Ferte, Deæ pelagi, et pingui conchylia succo."  
*N. Parthenii Giannettasii* Ecl. 1.

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No. 25. JANUARY 1880.

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I.—*On the Squillidæ.* By EDWARD J. MIERS, F.L.S., F.Z.S.,  
Assistant in the Zoological Department, British Museum.

[Plates I.–III.]

IN the present revision of the genera and species of the Squillidæ (a group which, in the most recent systems of classification, constitutes the single family of the Stomatopoda) I have not included the numerous pelagic forms which were formerly assigned to several distinct genera (i. e. *Erichthus*, *Alima*, *Squillerichthus*, &c.) in the family Erichthidæ, but were demonstrated by Fritz Müller\* to be but the larval condition of the adult Stomatopod, and whose successive stages of development have been so ably investigated and illustrated by Dr. Claus†. In the present paper I have restricted myself to the description of such forms as are undoubtedly adult, and have endeavoured to facilitate their determination by brief comparative descriptions of the several genera and species, supplemented by notes on their geographical distribution, based on the materials afforded by the collection of the British Museum. It would seem that a revision of this kind is much

\* *Vide* Müller, Arch. f. Nat. 1862, p. 353, 1863, p. 1; 'Für Darwin,' English translation by Dallas, p. 67 (1869).

† "Die Metamorphose der Squilliden," in Abhandl. könig. Gesellsch. zu Göttingen, xvi. p. 111 (1872).

needed, as no general account of the group has appeared since the publication of the second volume of Milne-Edwards's 'Histoire naturelle des Crustacés' in 1837; and since that period numerous species have been described, not a few of which, having been based on characters of insufficient value, are now reduced to the rank of synonyma. In Milne-Edwards's work the number of distinct species does not exceed twenty; in the present revision fifty-three species are enumerated, distributed into six genera.

Milne-Edwards, in 1837, enumerated three genera, *Squilla*, *Coronis*, and *Gonodactylus*, and divided the genus *Squilla* into two sections of subgeneric value, to include respectively the "*Squilles fines-tailles*" and "*Squilles trapues*." Dana, in 1852\*, established the genus *Pseudosquilla* for Milne-Edwards's "*Squilles trapues*," and *Lysiosquilla* for the first section of his "*Squilles fines-tailles*." De Haan†, on the other hand, only retains the genera *Squilla* and *Gonodactylus*, reuniting with *Squilla* not only Dana's *Lysiosquilla*, but also the genus *Coronis* of Latreille. As regards *Coronis*, De Haan is undoubtedly right; for this genus differs from *Lysiosquilla* only in the dilated and orbiculate appendage of the antepenultimate joint of the thoracic limbs; and to the fact, already observed by De Haan, that in young *Lysiosquilla maculata* the form of this appendage approaches that of *Coronis*, I may add that, in a species (*L. Brazieri*) described below, the appendages of the fifth and sixth thoracic limbs are dilated as in *Coronis*, and those of the seventh pair linear and styliform as in the typical *Lysiosquilla*, and thus a complete transition is established from the one genus to the other.

In the present revision, the species of Squillidæ are distributed into six genera, the characters of which may be tabulated as follows:—

- I. Ophthalmic segment greatly elongated; rostrum not reaching beyond half the length of this segment ..... LEPTOSQUILLA.
- II. Rostrum reaching to the end of the ophthalmic segment.
  - 1. Dactyli of the raptorial limbs not dilated at base.
    - Carapace not costate. Postabdomen loosely articulated and depressed; terminal segment transverse, marginal spines small. Eye-peduncles usually dilated at the distal end ..... LYSIOSQUILLA.

\* Crust. U.S. Explor. Expedition, xiii. p. 615 (1852).

† Crust. in v. Siebold's Fauna Japonica, p. 220 (1849).

Carapace and postabdomen as in *Lysiosquilla*.

Eye-peduncles ovoid, dilated in their middle portion, and constricted at the distal end; cornea very small . . . . . CHLORIDELLA.

Carapace usually costate. Postabdomen compactly articulated; terminal segment with well-developed marginal spines. Eye-peduncles dilated at the distal end . . . . . SQUILLA.

Carapace not costate. Postabdomen convex, compactly articulated, smooth; terminal segment with two well-developed mobile spines at its distal end. Eye-peduncles subcylindrical, but little dilated at the distal end . . . . . PSEUDOSQUILLA.

2. Dactyli of the raptorial limbs dilated at base.

Carapace and postabdomen nearly as in *Pseudosquilla* . . . . . GONODACTYLUS.

The genera, it will be observed, are separated by characters of little importance. The distinction between *Pseudosquilla* and *Gonodactylus* is, indeed, an artificial one; and it might have been better to have restricted the former genus to the *Pseudosquilla Lessonii*, which is characterized by the great development of the antennules and the form of the basal portion of the uropoda; in practice, however, it is more convenient to adhere to the long-established diagnosis, based on the form of the dactyli of the raptorial limbs, which affords a ready means of separating the species, and from which the name *Gonodactylus* derives its significance.

### List of the Genera and Species.

#### LYSIOSQUILLA.

- L. maculata* (Fabr.). Indo-Pacific Region.
- L. glabriuscula* (Lam.). West Indies.
- L. scabricauda* (Lam.). Atlantic Region.
- L. Desaussurei* (Stimps.). Pacific coast of North America.
- L. scolopendra* (Latr.). Brazil?
- L. eusebia* (Risso). Mediterranean.
- L. latifrons* (De Haan). Japan.
- L. Brazieri*, Miers. Australia, Port Jackson.
- L. acanthocarpus* (White, ined.). Australia, Port Essington.
- L. spinosa* (Wood-Mason). Andamans, New-Zealand Seas.

#### LEPTOSQUILLA.

- L. Schmeltzii* (A. Milne-Edwards). Samoa Islands.

#### CHLORIDELLA.

- C. microphthalma* (M.-Edwards). Australian and Indian Seas.
- C. rotundicauda*, Miers. Formosa.
- C. Latreillei* (Eydoux and Souleyet). Singapore.
- C. decorata* (Wood-Mason). Andamans.

## SQUILLA.

- S. Ferussacii*, *Roux*. Mediterranean.  
*S. miles*, *Hess*. Australia.  
*S. scorpio*, *Latr.* Seas of Asia and Australia.  
*S. Dufresnii*, *Leach* (ined.). Hab. — ?  
*S. prasino-lineata*, *Dana*. Brazil.  
*S. supplex*, *Wood-Mason*. India, Bombay.  
*S. multicarinata*, *White*. Seas of Eastern Asia.  
*S. costata*, *De Haan*. Japan.  
*S. mantis*, *Latr.* Mediterranean, British Channel.  
*S. empusa*, *Say*. Atlantic Region.  
*S. neglecta*, *Gibbes*. Charleston Harbour, United States.  
*S. dubia*, *M.-Edwards*. West Indies, east coast of America.  
*S. nepa*, *Latr.* Indo-Pacific Region.  
*S. armata*, *Milne-Edwards*. Chili, Auckland Islands.  
*S. raphidea*, *Fabr.* Indo-Pacific Region.  
*S. Desmarestii*, *Risso*. Mediterranean, British Channel.  
*S. fasciata*, *De Haan*. Japan.

## PSEUDOSQUILLA.

- P. ciliata* (*Fabr.*). Indo-Pacific Region; Cuba (*Von Martens*).  
*P. oculata* (*Brullé*). Canaries, Madeira.  
*P. monodactyla* (*A. M.-Edwards*). Hab. — ?  
*P. ornata*, *Miers*. Philippine Islands, Tahiti?  
*P. stylifera* (*M.-Edwards*). Chili.  
*P. empusa* (*De Haan*). Japan.  
*P. Lessonii* (*Guérin*). Chili, California?  
*P. Cerisii* (*Roux*). Mediterranean.

## GONODACTYLUS.

- G. scyllarus* (*Linn.*). Indo-Pacific Region.  
*G. japonicus*, *De Haan*. Japan, China.  
*G. cultrifer*, *White*. China.  
*G.*? *Bradyi* (*A. Milne-Edwards*). St.-Vincent Bay.  
*G. Bleekeri*, *A. Milne-Edwards*. Batavia.  
*G. chiragra* (*Fabr.*). Indo-Pacific Region, Mediterranean, W. Indies, E. coast of S. America.  
*G. graphurus*, *White* (ined.), *Miers*. Indo-Pacific Region.  
*G. Guérinii*, *White*. Fiji Islands.  
*G. trispinosus*, *White* (ined.), *Dana*. Fiji Islands, New Zealand, Australia (Swan River and Sharks' Bay).  
*G. trispinosus*, var. *pulchellus*, *Miers*. Ceylon.  
*G. glyptocercus*, *Wood-Mason*. Nicobars.  
*G. Polinii*, *A. M.-Edwards*. Cape St. Vincent, Mauritius?  
*G. excavatus*, *Miers*. Hab. — ?  
*G. furcicaudatus*, *Miers*. Hab. — ?

The Squillidæ, as will be seen from the foregoing list, inhabit all the warmer temperate and tropical seas of the globe; and the geographical range of the various species is often very extended. As the females deposit their eggs in holes in the ground, the ova are never seen upon specimens in collections; but the females may always be distinguished from the males

by the absence of the long copulatory appendages which arise from the bases of the last cephalothoracic limbs in the latter sex.

In the present paper it has not been thought necessary to describe more than one or two typical species of each genus in detail; of the other species only the principal distinctive characters are indicated.

### LYSIOSQUILLA.

*Coronis*, Latreille, Fam. naturelles Règne Anim. p. 183 (1825); Encycl. Méth. Hist. Nat. x. p. 474 (1825); Crust. in Cuvier, Règne Anim. iv. p. 109 (1829); M.-Edwards, Hist. Nat. Crust. ii. p. 530 (1837): *nom. præoc.*

*Squilla* (§), M.-Edwards, Hist. Nat. Crust. ii. p. 518 (1837).

*Squilla* (sect. i. *Maculatae*), De Haan, Faun. Jap. Crust. p. 220 (1849).

*Lysiosquilla*, Dana, Crust. U.S. Expl. Exped. xiii. p. 615 (1852).

Carapace not longitudinally costate, the cervical suture posteriorly obsolete. Rostral plate reaching to, but usually not covering, the base of the eye-peduncles. The five exposed thoracic segments and the segments of the postabdomen loosely articulated and depressed; the latter are wider than the thoracic segments, and are not longitudinally carinate; the terminal segment is transverse; and the two mobile spines of the posterior margin are absent or very minute. Dactylus of the raptorial limbs not dilated at base, and armed on its inner margin with long and usually numerous spines. The appendages of the three posterior pairs of thoracic limbs are slender and styliform, or dilated and compressed.

Sect. 1. *Appendages of the antepenultimate joint of the three posterior pairs of thoracic limbs compressed, but scarcely dilated, almost linear.* (*Lysiosquilla*, Dana.)

#### *Lysiosquilla maculata.* (Pl. I. figs. 1, 2.)

*Squilla arenaria*, Rumph, Amboin. Rarit. p. 6, pl. iii. fig. E (1705).

*Squilla maculata*, Fabr. Ent. Syst. ii. p. 511 (1793), Suppl. p. 415 (1798); Lamarek, Hist. Anim. sans Vert. v. p. 188 (1818); Desm. Consid. Crust. p. 250 (1825); Latr. Encycl. Méth. Hist. Nat. x. p. 470 (1825); M.-Edwards, Hist. Nat. Crust. ii. p. 518, pl. xxvi. fig. 11 (1837); De Haan, Faun. Japon. Cr. p. 221 (1849); White, List Crust. Brit. Mus. p. 83 (1847).

*Cancer (Mantis) arenarius*, Herbst, Nat. Krabben u. Krebse, ii. p. 96, pl. xxxiii. fig. 2 (1796).

*Lysiosquilla maculata*, Miers, P. Z. S. p. 138 (1877); Philosoph. Trans. Roy. Soc. clxviii. p. 494 (1879).

Carapace smooth, oblong-oval, somewhat widening posteriorly, and rounded at its antero-lateral and postero-lateral angles, without longitudinal carinae. Rostrum semioval, flattened, and acuminate at its distal end. The exposed thoracic



segments and the segments of the postabdomen are smooth; the three posterior thoracic segments similar to, but narrower than the postabdominal segments. None of the segments bear lateral spines. Terminal segment transverse, with a slight median longitudinal elevation; the posterior margin straight, with a slight median emargination; there are, on each side, three postero-lateral marginal teeth, of which the two outer only are acute. Eyes large. Antennules and antennæ small and slender; the second, third, and fourth joints of the antennæ bear each a small appendage on their inner or under sides; the basal antennal scale is large, lamellate, and ciliated. The first maxillipedes are slender, elongated, and terminate in a flattened, dilated, and ovate joint. The large raptorial limbs (second maxillipedes) are very powerful and greatly elongated; the penultimate joint or propus is very finely denticulated and armed with four strong mobile spines near its base, and the terminal joint (in the male) with nine or ten very strong spines. The penultimate joint of the three following limbs is considerably enlarged, produced and rounded posteriorly. The appendage to the antepenultimate joint of the three posterior thoracic limbs is styliform and slender in the adult. The rami of the postabdominal appendages are foliaceous and very greatly enlarged. The distal ends of the basal portions of the appendages of the sixth segment are armed below with two exceedingly strong spines and a single spine above; and the rami are ovate, the terminal joint of the inner being slightly the larger. Length of the largest male upwards of 12 inches.

*Hab.* Indo-Pacific Region.

This, which is the largest and perhaps the most strikingly coloured, is also one of the commonest and most widely distributed species of the genus. Specimens are in the British-Museum collection from Rodriguez (*H. H. Slater, Esq.*), Indian Ocean (*Mus. Leach*), Duke-of-York Island (*Rev. G. Brown*), Philippine Islands (*H. Cuming, Esq.*), Fiji Islands (*H.M.S. 'Herald'*), Sandwich Islands (*W. H. Pease, Esq.*), Samoa Islands (*Rev. S. J. Whitmee*), Eastern Seas (*Madame Ida Pfeiffer*) \*.

The only females I have seen are two collected by Mr. Whitmee at the Samoa Islands; and in the only one possessing the large raptorial limbs, the spines arming the inner margin of the dactyl, instead of being strong and elongated as in the

\* There is in the British Museum a fine male example of this species, obtained from H.B.M. Consul Petherick, and stated to have come from the "White Nile." It was, in all probability, obtained in the Red Sea, as I am informed by Dr. J. Murie, who accompanied Consul Petherick, that the latter gentleman took ship on his return at Suakin, on the Red-Sea coast.

males, are very short, and toward the base are reduced to little more than small serratures or teeth (see fig. 2).

*Lysiosquilla glabriuscula.*

? *Squilla glabriuscula*, Lam. Hist. Anim. sans Vert. v. p. 188 (1818); Latreille, Encycl. Méth. Hist. Nat. x. p. 470 (1825); M.-Edw. Hist. Nat. Crust. ii. p. 519 (1837).

*Squilla vittata*, M.-Edw. Hist. Nat. Crust. ii. p. 519 (1837); White, List Crust. Brit. Mus. p. 83 (1847); Gibbes, Proc. Amer. Assoc. p. 199 (1850).

The principal distinction between this species and *Lysiosquilla maculata* consists in the smaller number of the spinules with which the terminal joint of the large raptorial limbs is armed. In *L. maculata* these are, as has been stated, nine or ten in number; in *L. glabriuscula* there are only from five to seven.

*Hab.* West Indies.

Two specimens, both of them males, are in the British Museum from the West Indies, St. Vincent (*Rev. Lansdowne Guilding*).

Slight as the character separating this species from its Indo-Pacific congener may appear, it is probably permanent. The two specimens in the Museum collection are of smaller size than average-sized examples of *L. maculata*; but in smaller examples of this latter species the spines on the dactylus of the raptorial limbs are not less numerous than in fully-grown individuals. With regard to the coloration of *L. glabriuscula*, it may be observed that the tripartite division of the dark transverse bands, noted by Milne-Edwards, is observable only in the anterior band of each segment in one of the Museum specimens.

The description of *L. glabriuscula* as given by Lamarek and Latreille seems to refer to this species, although its identification must remain uncertain, as the habitat is doubtfully given as the Indian Ocean by the authors above named. On the other hand, the habitat of St. Vincent is given by Latreille for *L. maculata*. May there not have been here some confusion of localities?

*Lysiosquilla scabricauda.*

*Squilla scabricauda*, Lam. Hist. Anim. sans Vert. v. p. 188 (1818); Latreille, Encycl. Méth. Hist. Nat. x. p. 470 (1825), Atlas, pl. cxxv. fig. 1; Desm. Consid. Crust. p. 251, pl. xlii. (1825); M.-Edw. Hist. Nat. Crust. ii. p. 519 (1837); Gibbes, Proc. Amer. Assoc. p. 199 (1850); S. I. Smith, Trans. Conn. Acad. ii. p. 41 (1869).

*Squilla Hoeveni*, Herklots, Addit. Faun. carcin. Afric. occident. p. 17, pl. i. fig. 11 (1851).

*Lysiosquilla mornata*, Dana, U.S. Expl. Exped. xiii. (Cr. i.) p. 616, pl. xli. fig. 1 (1852).

Mainly distinguished by the sculpture of the last two post-abdominal segments, which have the dorsal surface finely granulated. The posterior margin of the antepenultimate segment, both the anterior and posterior margins of the penultimate segment, and the anterior margin of the last segment are armed with a series of small spinules. The terminal segment is armed on its upper surface with an elevated longitudinal median shield-like prominence; its three postero-lateral marginal teeth are very strong and acute; and its posterior margin, on either side of the median emargination, is divided into several small truncated lobules or denticles. The dactyli of the raptorial limbs bear nine or ten long spines. The upper surface of the basal portion of the uropoda bears several unequal spinules. The coloration is similar to that of *L. maculata*; but the bluish or dusky transverse bands are (if one may judge from dried specimens) narrower than in that species.

*Hab.* Atlantic Region.

Specimens are in the British Museum from Brazil (*Lord Stuart de Rothsay* and *John Miers, Esq., F.R.S.*).

Milne-Edwards records this species from the West Indies, Gibbes from Charleston Harbour, South Carolina, Latreille from Cayenne, and Herklots from Boutry, on the west coast of Africa (as *S. Hoeveni*).

It is probably to this species that a *Squilla* noticed by Dr. A. Ernst (P. Z. S. 1870, p. 3), as having been captured at La Guayra, Venezuela, is to be referred.

In a dried individual which is apparently of the female sex, the spines of the dactyli of the raptorial limbs are in all respects similar to those of male individuals.

The denticles of the posterior margin of the terminal segment vary greatly in size and number. Dana probably separated his *L. inornata* on account of the differences presented in this respect between his specimens and Milne-Edwards's description of *L. scabricauda*; but they cannot be regarded as of specific value.

### *Lysiosquilla Desaussurei.*

*Squilla scabricauda*, De Saussure, Rev. et Mag. Zool. v. p. 367 (1853);  
*nec* Latr.

*Squilla Desaussurei*, Stimpson, Boston Journ. Nat. Hist. vi. p. 503 (1857).

Stimpson evidently founded this species on the description of M. de Saussure, who says (*l. c.*) that his specimens differed from those of *L. scabricauda* in the Paris Museum in having the dactyli of the raptorial limbs armed with eleven teeth (the

terminal included) instead of eight, as in the Paris specimens—moreover, in having the constricted portion of the arm at its articulation with the wrist much more elongated, and the anal shield (terminal segment) more spinous.

*Hab.* Mazatlan (Pacific coast of Mexico).

Not having seen specimens, I cannot express any definite opinion with regard to the distinctness of this species from its Atlantic congener.

Sect. 2. *Appendages of the antepenultimate joint of the three posterior pairs of thoracic limbs compressed and greatly dilated, ovate or orbiculate-ovate* \*.  
(*Coronis*, *Latr.*)

*Lysiosquilla scolopendra.*

*Coronis scolopendra*, *Latr. Encycl. Méth.* x. p. 474 (1825); Guérin, *Icon. R. A. Cr.* pl. xxxiv. fig. 2; M.-Edw. *Hist. Nat. Crust.* ii. p. 531 (1837); M.-Edw. *Cr. in Cuv. Règne Anim.* pl. lv. fig. 3.

*Latreille* describes this crustacean as having a narrower and more depressed form than that of *Squilla*, and shorter antennæ and legs. The carapace is of a deep brown, and generally smooth, with some small raised lines, in the shape of fine longitudinal striæ, on a depression in the middle of the dorsal surface of most of the segments. The rostral plate is nearly triangular, and acute at the end. The terminal post-abdominal segment is nearly square, a little obliquely truncate at each postero-lateral angle, elsewhere entire, without teeth or distinct spines. The raptorial limbs are whitish and spotted with brown. The penultimate joint is oval, greatly compressed, but somewhat more convex on one of its surfaces, with the inner margin clothed with very small numerous spinuliform cilia, and armed at base with three or four mobile spines; the dactylus is like that of *Squilla*, falcate or arcuate, with a dozen acute teeth on its inner margin, the terminal spine being the largest.

This crustacean formed part of a collection of Crustacea made by M. Lalande at Brazil; but as it had great affinity with the *L. eusebia*, *Risso*, it might, in M. *Latreille's* opinion, have been obtained on the coast of the island of Madeira, where M. Lalande stayed and collected for a few days. When Milne-Edwards was engaged on the description of this genus, in the second volume of the 'Hist. naturelle des Crustacés,' the type was no longer to be found in the collection of the Paris Museum.

\* In *L. Brazieri*, as noted above, the appendages of the last pair of legs are not dilated.

*Lysiosquilla eusebia.*

*Squilla eusebia*, Risso, Crust. de Nice, p. 113 (1816); Hist. Nat. Europe Mérid. v. p. 87, pl. iv. fig. 15 (1826); Kessler, Horæ Soc. entom. Rossicæ, iv. p. 41, pl. i. fig. 5 (1866-67); Nardo, Annot. Crostacei, in Mem. Instit. Veneto, p. 328, pl. xiv. fig. 7 (1868).

According to M. Risso, the head terminates in a long spine (the rostral plate); the carapace is nearly flattened, oblong, smooth, with brown punctulations; the eyes are greenish; the lateral scales (antennal scales?) oval, ciliated; the first pair of legs rather long, filiform, armed with ten very slender pectinately-disposed spines, the other legs short, nacreous; the postabdominal segments smooth, rounded, but little convex, of a rosy red, punctulated with brown, the first three less dilated than the median ones, the last armed with six small spines on each side and eight scarcely discernible ones on its summit; caudal plates oval, ciliated, the median one (basal prolongation?) with two spines, the terminal one very small.

*Hab.* Mediterranean.

According to M. Kessler, the rostral plate in this species is quadrangular, somewhat broader than long, its anterior margin with a sharp tooth-like median lobe; the dactylus of the raptorial limbs is armed with eleven spines (besides the terminal spine) in his specimens.

*Lysiosquilla (Coronis) latifrons.*

*Squilla latifrons*, De Haan, Faun. Japon. Crust. p. 222, pl. li. fig. 3 (1849).

Carapace longer than broad; posterior margin twice as broad as the anterior, with the antero-lateral angles obtuse and the postero-lateral broadly rounded. Rostrum broader than long, with the antero-lateral angles rounded, and with a long median spine. A small spine on each side of the antennal segment. Dactyli of the raptorial limbs with seven spines. Lateral processes of the exposed thoracic segments truncate. Appendages of the thoracic limbs ovate, and broader than in the young *L. maculata*. Sixth postabdominal segment obliquely sulcated near the lateral margin; posterior margin entire, with only a single spine near the postero-lateral angles. Seventh segment twice as broad as long, convex, with seven spinules disposed in a transverse series behind the middle line; the median flat, trigonous, and not produced at base, the next on each side produced at base on its outer margin, the third somewhat thickened at base; postero-lateral margin with three narrow acute spines (the last mobile), a



single spinule between the anterior spines, three between the posterior; posterior margin with about ten very minute spinules, separated by a sinus in the middle line; lower surface with a spine behind the anus. Inner spine of the basal prolongation of the uropoda unispinose at base on its inner margin.

*Hab.* Japan.

The above description is modified and considerably abridged from that of De Haan. I have seen no specimens of this species.

*Lysiosquilla Brazieri*, sp. n. (Pl. I. figs. 3-6.)

I designate by this name a female specimen, obtained by John Brazier, Esq., at Port Jackson in three fathoms of water, on the Sow-and-Pigs Bank. It is evidently closely allied to *L. latifrons*, but differs in having the dactyli of the raptorial limbs six-spined, in the posterior margin of the terminal segment being without a median sinus, and armed with more numerous spinules (about fourteen), and particularly in the appendages of the last pair of thoracic limbs being scarcely dilated, almost linear, whereas those of the two preceding pairs are ovate and broadly expanded. In this respect this interesting form establishes a complete transition between the typical *Lysiosquilla* and *Coronis*. The unique example was presented by its discoverer to the British Museum; and I have much pleasure in dedicating the species to him.

*Lysiosquilla acanthocarpus*. (Pl. I. figs. 7-9.)

*Coronis acanthocarpus*, Gray (ined.), White, List Crust. Brit. Mus. p. 85 (1847), descript. nulla.

The principal distinctive characters of this species are the following:—The dilated basal portion of the rostral plate is nearly quadrate, the antero-lateral angles being right angles and not produced into spines; the terminal median spine is rather short and somewhat triangular, broadest at base. The last postabdominal segment has six small similar spines in a transverse series on its upper surface; the lateral spines and intervening spinules are nearly as in *L. tricarinata*. The dactyli of the raptorial limbs are armed with six spines, the one next the terminal spine being very small. The distal prolongation of the basal portion of the uropoda ends in two simple slender spines, the inner being the longer. Length about  $2\frac{1}{2}$  inches.

The single specimen collected (a female) was obtained at Port Essington by Sir J. Richardson, by whom it was presented to the British Museum.

*Lysiosquilla spinosa.* (Pl. I. figs. 10-12.)

*Coronis spinosa*, Wood-Mason, Proc. Asiatic Soc. Bengal, p. 232 (1875).

? *Squilla indefensa*, Kirk, Ann. & Mag. Nat. Hist. (ser. 5) ii. p. 466 (1878).

Is described by Mr. Wood-Mason as having three spines projecting from the telson, just above the level of the marginal ones, of which there are three pairs; the median pair movable and smaller than the rest, and with the interval between them finely serrated (five or six teeth on each side of the middle line), between these and each lateral pair two spinules, between the teeth of each lateral pair one spinule; dactyli of raptorial limbs 10-toothed.

It inhabits the Andamans and the seas of New Zealand.

I refer the *Squilla indefensa* of Kirk, from Chatham Island and Kapiti, to this species, because his short description agrees with Mr. Wood-Mason's diagnosis; but more details are needed to render the identification certain. Kirk describes the rostral plate as semioval and acute at its distal extremity, and the carapace as retracted in front, expanded and rounded behind, smooth, with the antero-lateral angles rounded and slightly produced forwards.

It is very probable that the *Lysiosquilla tricarinata* (*Coronis tricarinata*, Gray, ined., White, List Cr. Brit. Mus. p. 85, 1847) is identical with this species. The unique example, a male, was collected in the Antarctic expedition under Captain Sir J. C. Ross; and the locality has not been preserved. Kirk's description applies very well to this specimen; but no mention is made in it of the spinules between the marginal spines of the terminal postabdominal segment. There are in *L. tricarinata* about a dozen minute spinules between the submedian marginal spines, between the submedian and second marginal spines two or three spinules on each side, and between the second and third marginal spines one, as in *C. spinosa*; the dactylus of the raptorial limbs is armed with only nine spines on its inner margin, including the terminal spine.

## LEPTOSQUILLA, gen. nov.

This genus is distinguished from all others of this family by the form of the ophthalmic segment, which is greatly elongated and prolonged beyond the rostrum for more than half its length. The eye-peduncles are very slender, elongated, and compressed, not dilated in the middle as in *Chloridella*, or at the distal end as usual in *Squilla*. The appendages of the thoracic limbs are almost linear, not dilated.

The carapace is very short; the two dorsal carinæ of the first to fifth postabdominal segments are obsolete. The terminal segment is well developed. If the figure be correct, the dactyli of the raptorial limbs are thickened at base, as in *Gonodactylus*, and have six spines on their inner margins.

*Leptosquilla Schmeltzii.*

*Squilla Schmeltzii*, A. M.-Edwards, J. Mus. Godeffroy, i. (pt. iv.) p. 87, pl. ii. fig. 7 (1873).

Carapace rather narrow, with the antero-lateral angles spiniform and not very prominent. Rostral plate small and obtuse. Postabdominal segments with two prominent carinæ on each side, which are produced into spines on the sixth segment; terminal segment broader than long, armed above with a median carina and with six acute marginal teeth. Dactyli of the raptorial limbs with seven spines (including the terminal spine), margin of the penultimate joint finely denticulated. Uropoda greatly reduced in size; thoracic limbs very small.

*Hab.* Upolu, Samoa Islands.

I have seen no specimens of this species. Its colour is a bright grey.

I have taken the above description from Milne-Edwards. In the figure the penultimate postabdominal segment is six-spined. The terminal segment is represented as having about six spinules between the submedian spines of the posterior margin, and half a dozen more on each side between these and the next spines.

CHLORIDELLA\*.

*Chlorida*, Eydoux and Souleyet, Voy. de la Bonite, Zool. i. Crust. p. 264 (1841); Dana, U.S. Expl. Exp. xiii. Cr. i. p. 615 (1852), footnote.

This genus is very nearly allied to *Squilla*, and particularly to the species comprised in Section A in the present revision, but differs in the form of the eye-peduncles, which are of an ovoid form, greatly dilated in their middle portion, and constricted at the extremity, the cornea being very small and terminal. The rostral plate and carapace are very small, the former not reaching nearly to the base of the eye-peduncles. The cervical suture is posteriorly distinct. The appendages of the thoracic limbs (in the specimen of *C. microphthalma* in the Museum collection and in *C. Latreillei*) are somewhat

\* The name given to this genus having been preoccupied among the Coleoptera, I have slightly modified its termination.

strap-shaped and dilated, but not to so great an extent as in the typical species of the section *Coronis* of the genus *Lysiosquilla*.

The *Squilla ichneumon* of Fabricius, Ent. Syst. Suppl. p. 416 (1798), may belong either to this genus or to a species of the first section of the genus *Squilla*.

The *Squilla phalangium* of the same author (*l. c.*) is so briefly described that it is impossible to say whether it belongs to this genus, *Lysiosquilla*, or *Pseudosquilla*; in the five-spined dactylus of the raptorial limbs, which has the third and fifth spine longest, it appears to resemble *Lysiosquilla acanthocarpus*; and that species may prove to be identical with it.

*Chloridella microphthalma.* (Pl. II. figs. 1-4.)

*Squilla microphthalma*, M.-Edwards, Hist. Nat. Crust. ii. p. 523 (1837).

*Chlorida microphthalma*, Eydoux and Souleyet, Voy. Bonite, Cr. p. 266 (1841).

A single specimen, which I refer to this species, is in the Museum collection. The body is somewhat loosely articulated and depressed. The carapace is smooth, widening posteriorly, with a small spine at the antero-lateral and broadly rounded at the postero-lateral angles. The rostral plate is small, semioval, and regularly rounded. The fourth thoracic segment is scarcely at all laterally produced, but is armed on each side with a very small spinule; the fifth, sixth, and seventh are broader, but little produced and rounded on the sides; the first to fifth postabdominal segments are smooth in the middle of the dorsal surface, but are faintly marked with two lateral carinæ; the postero-lateral angle of each segment is acute; on the sixth segment the submedian as well as the lateral carinæ are present, and all terminate in spines. The terminal segment is broader than long, with a median obtuse crest, and on either side of it several irregular tubercles, and with six acute marginal teeth, between which are a number of smaller spiniform teeth. The antennal scale is very small. The dactyli of the raptorial limbs are four-spined, the terminal spine being very long. The uropoda are small; the basal prolongation is armed on its inner margin with a series of small spinules (as in *C. decorata*); the inner of its two terminal spines is the longest, and armed with a blunt tooth on its outer margin. Length about  $1\frac{1}{2}$  inch.

The specimen in the Museum collection is a male, and was obtained at Port Essington by Mr. R. Tilston. Its integument is remarkably thin and fragile. It differs somewhat in the form of the rostral plate from Milne-Edwards's description

of that part in *C. microphthalma*. If distinct, I would propose for it the name of *C. depressa*.

MM. Eydoux and Souleyet obtained *C. microphthalma* at Singapore.

*Chloridella rotundicauda*, sp. n. (Pl. II. figs. 5, 6.)

This species is nearly allied to *C. microphthalma*, but differs as follows:—The rostrum is somewhat more elongated; there is no spine at the antero-lateral angles of the carapace. The carinæ of the first to fifth postabdominal segments are very faintly indicated; those of the sixth segment are strongly defined. The median carina of the terminal segment is thickened and obtuse posteriorly; the lateral marginal spines are obsolete, and the intervening denticles are small and not acute. The eye-peduncles have the inner margins straight, and are convex only on their outer surface. Length  $2\frac{3}{4}$  inches.

A single female is in the collection from Formosa (*R. Swinhoe, Esq.*). It is possible that it may prove to be only an adult state of *C. microphthalma*.

*Chloridella Latreillei*.

*Chlorida Latreillei*, Eydoux and Souleyet, Voy. Bonite, Cr. p. 265, pl. v. figs. 2-5 (1841).

This species is very nearly allied to *C. microphthalma*, but differs in the form of the rostral plate, which is much broader than long and slightly emarginate at its distal end. The antennules are described as large and much longer than the antennæ. The inner of the terminal spines of the basal portion of the uropoda is represented in the figure as having two acute teeth on its outer margin.

The raptorial limbs were wanting in the type, which was obtained at Singapore.

*Chloridella decorata*.

*Chlorida decorata*, Wood-Mason, Proc. Asiatic Soc. Bengal, p. 231 (1875).

This species has, according to Mr. Wood-Mason, eyes as in *C. microphthalma* and *C. Latreillei*. The inner margin of the sabre-like appendage (basal prolongation) of the uropoda is armed with fine acuminate spines; and the terminal postabdominal segment is vermiculated above and below with granulated ridges; the dactyli of the raptorial limbs are five-toothed.

This species inhabits the Andamans. I have seen no specimens.

## SQUILLA.

*Squilla*, Fabr. (part.), Ent. Syst. ii. p. 511 (1798); Latreille (part.), Hist. Nat. Crust. vi. p. 271 (1803); Encycl. Méth. Hist. Nat. x. p. 467 (1825); Lamarek (part.), Hist. Anim. sans Vert. v. p. 186 (1818); M.-Edwards (part.), Hist. Nat. Cr. ii. p. 517 (1837); De Haan (part.), Faun. Japon. Cr. p. 220 (1849); Dana, Cr. U.S. Expl. Exp. xiii. i. p. 615 (1852).

Carapace usually marked with more or less distinct longitudinal costæ. Cervical suture posteriorly distinct. Rostral plate rarely covering the base of the eye-peduncles. The four or five posterior exposed thoracic segments and the post-abdominal segments are compactly articulated, the latter marked with six or eight longitudinal carinæ; terminal segment without or with two very minute mobile spines at its distal end. Dactylus of the raptorial limbs not dilated at base, and armed with long spines on its inner margin. The appendages of the three posterior thoracic limbs are slender and styliiform.

- A. The exposed thoracic segments and the first to fifth postabdominal segments with the dorsal surface marked with submedian carinæ; terminal segment usually without mobile spines at its distal end.

I. *Penultimate joint of the raptorial limbs without a series of immobile marginal spines.*

\* *Dactyli of the raptorial limbs armed with three spines.*

*Squilla Ferussacii.*

*Squilla Ferussacii*, Roux, Crust. de la Méditerranée (livr. 6), pl. xxviii. (1830); M.-Edwards, Hist. Nat. Crust. ii. p. 525 (1837); Heller, Cr. südl. Europa, p. 308 (1863); Haller, Zool. Anzeiger, p. 207 (1879).

Carapace widening posteriorly. Rostrum transverse, apparently covering the ophthalmic segment, and divided by a slight median emargination into two lobes. The median as well as the lateral ridges of the postabdominal segments are very distinctly defined: the terminal segment is armed with eight strong marginal spines, but is without any intervening denticles; on its upper surface, on each side of the strong median, a smaller lateral ridge is shown in Roux's figure. The dactylus of the raptorial limbs is armed with only two slender spines, besides the strong terminal spine. The distal prolongation of the basal portion of the uropoda is represented as slender and elongated, with two lateral besides the long terminal spine. The dominant colour of the body

is, according to Roux, purple, washed in some parts with greenish. The dactyli of the raptorial limbs, antennules and antennæ, and cilia of the basal antennal scales and uropoda are red.

*Hab.* Mediterranean.

Having seen no specimens of this rare and beautiful species, I have taken the above description from the description and figure of Roux, whose examples were brought from Sicily by M. Caron. A single example has quite recently been recorded by Haller from Nice. In many of its characters it is allied to *Pseudosquilla*.

**\*\* *Dactyli of the raptorial limbs armed with four spines.***

*Squilla miles.*

*Squilla miles*, Hess, Archiv f. Naturgesch. p. 169, pl. vii. fig. 21 (1865).

Carapace elongated and narrowed anteriorly, with the cervical suture strongly defined and deeply sinuated posteriorly; on the postero-lateral regions of the carapace are two short lateral carinæ; the antero-lateral as well as the postero-lateral angles of the carapace are rounded. Rostrum ovate, smooth, somewhat longer than broad. The carinæ on the exposed thoracic and postabdominal segments are distinctly defined; on the fifth postabdominal segment the lateral carinæ, and on the sixth all the carinæ terminate in spines. On the sides of each segment, between the second and third carinæ, is a flattened triangulate prominence; the terminal segment is armed with five longitudinal median crests, and the interspaces with small irregular prominences; there are six strong marginal spines, and in the intervening spaces numerous smaller denticles. The submedian marginal spines end each in a small mobile spinule. The dactyli of the raptorial limbs are small and armed with three spines besides the terminal one. The distal prolongation of the basal portion of the uropoda terminates in two strong spines, of which the innermost is curved.

The length of this species, as given by Hess, is 17·2 centims. A male specimen in the Museum is only half the size ( $3\frac{1}{2}$  inches).

*Hab.* Australia, Sydney (*Mus. Göttingen*); Victoria (*Mus. Brit.*).

In the Museum specimen the ridge between the second and third carinæ on the first to fifth postabdominal segments is linear and oblique.

\*\*\* *Dactyli of the raptorial limbs armed with five spines.*

*Squilla scorpio.* (Pl. II. fig. 7.)

*Squilla scorpio*, Latr. Encycl. Méth. x. p. 472 (1825); M.-Edw. Hist. Nat. Crust. ii. p. 522 (1837); White, List Crust. Brit. Mus. p. 84 (1847).

Carapace with three longitudinal carinæ, which are interrupted by the distinctly marked cervical suture; the antero-lateral angles are armed with a short spine; and the postero-lateral lobes of the carapace have a slightly raised outer margin, and a short carina on the upper surface. The rostrum is suboblong, and armed with a short median ridge. The anterior of the exposed thoracic segments is produced laterally into a somewhat curved and falcate acute lobe, which is excavated above at base; the two following are but little laterally produced and rounded; the first to sixth postabdominal segments are armed with eight longitudinal carinæ, but are without any median carina or tubercle; on the fifth segment all except the submedian, and on the sixth segment all the carinæ terminate in spinules. The terminal segment is smooth on its upper surface, and is armed with a median carina; four small rounded lobes between the median, and four to five between the median and first lateral spines. The distal prolongation of the basal part of the uropoda terminates in two unequal spines. Length about 3 inches.

*Hab.* Asiatic and Australian seas.

Specimens are in the Museum collection from Port Essington (*Earl of Derby* and *J. Gould, Esq., F.R.S.*), North Australia (*Dr. J. R. Elsey*), and Shanghai (*R. Swinhoe, Esq.*). It is recorded by Latreille from Pondicherry.

In adult males the carinæ of the penultimate postabdominal segment, and the median carina and marginal teeth of the terminal segment, are considerably thickened. This peculiarity it not observable in a female (apparently adult) and two younger individuals in the Museum collection.

I have little hesitation in identifying the Museum specimens with Latreille's description, as he particularly mentions the form of the tooth-like lateral prolongation of the first exposed thoracic segment, while Milne-Edwards refers to the dilatation of the median ridge of the terminal postabdominal segment.

*Squilla Dufresnii.* (Pl. II. figs. 8, 9.)

*Squilla Dufresnii*, Leach (MS.), White, List Crust. Brit. Mus. p. 83 (1847), *sine descr.*

The two examples of this species in the Museum collection,



one of which bears Leach's MS. label, bear a very great resemblance to *S. scorpio*, but differ in the following particulars:—The median longitudinal carina of the carapace is bipartite posterior to the cervical suture; there is a distinct median dorsal carinule on each of the exposed thoracic and first to sixth postabdominal segments, which, however, does not reach to the anterior or posterior margin of the segment; the anterior of the exposed thoracic segments is laterally acute, but not curved and produced as in *S. scorpio*; and the two following segments are laterally truncated. Length about 3 inches.

*Hab.* Unknown.

One of the specimens (the one bearing Leach's label) is a male; but the carinæ of the penultimate and terminal postabdominal segments are not thickened as in *S. scorpio*.

*Squilla prasinolineata?*

(Pl. II. fig. 10.)

? *Squilla prasinolineata*, Dana, Crust. U.S. Expl. Exped. xiii. p. 620, pl. xli. fig. 3 (1852).

To this species I doubtfully refer a female *Squilla* in the Museum collection that is evidently very closely allied to both the preceding species. Its chief distinctive characters are as follows:—The rostrum is proportionally somewhat broader than in either of the foregoing species. The median longitudinal carina of the carapace is indistinctly furcate only in its anterior portion; the cervical suture is faintly marked; the median carinules of the exposed thoracic and first to sixth postabdominal segments are obsolete; the first exposed thoracic segment is laterally produced into a short acute process, which is not so much curved as in *S. scorpio*; the two following segments are also shortly laterally produced and acute, the terminal postabdominal segment is proportionally narrower and more elongated than in either *S. scorpio* or *S. Dufresnii*; there are about six small rounded lobes between the submedian marginal spines, and between these and the first lateral marginal spines. The distal prolongation of the basal portion of the uropoda terminates in two unequal spines, the inner of which has a small rounded tooth on its inner margin. Length  $2\frac{3}{4}$  inches.

*Hab.* Brazil.

I refer this specimen with some hesitation to *S. prasinolineata*, as Dana does not mention the acute lateral prolongations of the posterior thoracic segments, and describes the upper surface of the terminal postabdominal seg-

ment as faintly sulcated. His specimens were from Rio Janeiro.

*Squilla supplex.*

*Squilla supplex*, Wood-Mason, Proc. Asiatic Soc. Bengal, p. 232 (1875).

I am only acquainted with this species from Mr. Wood-Mason's short diagnosis, according to which each of the post-abdominal segments is armed with nine carinæ, arranged three in the middle and three on each side; the terminal segment has three short oblique ridges on each side, between which and the strong median ridge on each side is a row of confluent tubercles in the same straight line with the two median marginal teeth; dactyli of the raptorial limbs with five teeth.

*Hab.* Bombay.

*Squilla multicarinata.*

*Squilla multicarinata*, White, List Crust. Brit. Mus. p. 84 (1847); Proc. Zool. Soc. p. 144, pl. vi. fig. 1 (1848).

Carapace with the cervical suture scarcely defined, except in its posterior portion, and with the whole of its upper surface covered with very numerous closely-placed longitudinal carinæ, its antero-lateral angles terminating in a short spine. Rostrum oblong, with a median carina; the exposed thoracic and postabdominal segments are covered, like the carapace, with numerous longitudinal carinæ, which terminate posteriorly in small spines, the normal carinæ of each segment being somewhat more prominent than the rest. The fourth, fifth, and sixth thoracic segments are laterally bilobate; the terminal postabdominal segment is carinated as the preceding; the median carina terminates in a spinule; the interspaces between the terminal marginal spines contain six tubercles; and between these and the first lateral spines there are eight or nine. The uropoda are carinated above and below, and the distal prolongation of the basal portion terminates in two strong spines. Length about  $2\frac{5}{8}$  inches.

*Hab.* Seas of Eastern Asia. Specimens from the Philippine Islands (*Cuming*) and Nangasaki Bay (*H.M.S. 'Samarang'*) are in the Museum collection. The only male, one from the latter locality, is small and in a badly-preserved condition.

The dactyli of the raptorial limbs are normally five-spined; but the left-hand dactylus of one of the Philippine specimens is seven-spined.

\*\*\*\* *Dactyli of the raptorial limbs armed with six spines.*

*Squilla costata.*

*Squilla costata*, De Haan, Faun. Japon. Crust. p. 223, pl. li. fig. 5 (1849).

This species is described by De Haan as having the front truncated at apex. Sides of the thoracic segments bispinose; spines of the same form as in *S. nepa* (*S. oratoria*, De H.). In the median region of the thorax and postabdomen there are five straight, approximated, continuous, equal carinæ; between these and the three lateral carinæ the postabdominal surface is roughened with short curved carinules or raised tubercles; in the fifth segment eight, and in the sixth segment six of the carinæ terminate in a spine; in the middle of the posterior segment there are also five carinæ, of which the inner is less elevated than the lateral ones, and the outer are short and oblique. Terminal segment with a continuous curved carina on each side between the median ridge and lateral margin, with five oblique carinules, which become obsolete at base, and with the spines produced into carinæ. Dactyli of the raptorial limbs six-spined.

*Hab.* Japan.

Of this small species De Haan had several examples. I have seen no specimens. It evidently presents many affinities with *S. multicarinata*, but differs not only in the six-spined dactyli of the raptorial limbs, but also, it would appear, by the carapace not being marked with *carinulæ* or ridges.

*Squilla mantis.* (Pl. II. fig. 11.)

*Squille mante*, De Geer, Mém. pour servir à l'hist. des Insectes, vii. p. 533, pl. xxxiv. fig. 1 (1778).

*Squilla mantis*, Latr. Hist. Nat. Crust. vi. p. 278, pl. lv. fig. 1 (1802); Encycl. Méth. Hist. Nat. x. p. 471 (1825); Atlas, pl. cxcv. figs. 1, 7, and pl. ccxxiv.; Cuv. Règne Anim. iv. p. 108 (1829); Lam. Hist. Anim. sans Vert. v. p. 187 (1818); Risso, Hist. Nat. Eur. mérid. v. p. 85 (1826); M.-Edw. Hist. Nat. Crust. ii. p. 520 (1837); Crust. in Cuv. R. A. (ed. 3), Atlas, pl. lv. fig. 1; White, List Crust. Brit. Mus. p. 83 (1847); Lucas, Anim. artic. in Expl. Algérie, i. p. 50 (1849); Bell, Brit. Crust. p. 351 (1851); Johnson, Ann. & Mag. Nat. Hist. iii. p. 56 (1859); Heller, Crust. südl. Europa, p. 306, pl. x. figs. 15-19 (1863); B. Capello, J. Acad. Sci. Lisboa, p. 80 (1877).

? *Cancer (Mantis) digitalis*, Herbst, Naturg. Krabben, &c. p. 93, pl. xxxiii. fig. 1 (1796).

Carapace narrowed anteriorly, with the cervical suture strongly defined, with a longitudinal median and two lateral carinæ, the inner lateral carina being interrupted for a con-

siderable distance, and with a short spine at the antero-lateral angles. Rostrum oblong-oval, rounded at its distal end, and with a short median longitudinal carina. Exposed thoracic segments with six, and postabdominal segments with eight longitudinal carinæ; the median carina is obsolete, or very nearly so. The first exposed thoracic segment is laterally prolonged into a short straight acute lobe; the two following are laterally obliquely truncated, the lateral margins being entire and the postero-lateral angles acute; the last thoracic segment is not laterally produced, and is furnished with a small subacute prominence at its antero-lateral angle. On the first to fourth postabdominal segments all the carinæ, except the submedian ones, terminate in spinules; on the sixth segment, and usually on the fifth segment, all the carinæ end in spinules. The terminal segment is armed on its upper surface with a strong longitudinal median crest, which terminates in a spinule, and is covered with numerous shallow pits symmetrically disposed in curved lines; the spines of the lateral margin are considerably thickened; there are from six to eight denticles between the submedian spines of the posterior margin, and eight or nine rounded prominences terminating in spinules between the submedian and each of the first lateral marginal spines. The basal portion of the antennæ is without fleshy appendages; the basal scale is elongate-ovate and subacute; the spines of the dactyli of the raptorial limbs are all of them well developed; the distal prolongation of the basal portion of the uropoda terminates in two unequal spines, the lobe on the outer margin of the inner of these being obsolete or nearly so. Length rarely exceeds 7 inches.

*Hab.* Mediterranean (very common); Channel (very rare).

Specimens are in the British-Museum collection from Nice (*Old Collection*); Adriatic Sea (*G. Cuvier*); Gibraltar (*Mr. Laughrin*); Gulf of Aorta (*S. Saunders, Esq.*); Mediterranean, without precise locality (*Admiral Spratt, Mr. Laughrin*); and others without locality, among them one from Donovan's collection, labelled *S. vulgaris*, by Leach, and one collected by Surgeon Rayner, of H.M.S. 'Herald,' probably outside of European seas.

Prof. Bell records the capture of a single female, by Mr. Couch, on the south-west coast of England; and B. Capello includes it in his list of Crustacea of the coast of Portugal.

Bianconi (no doubt erroneously) refers specimens obtained at Mozambique to this species (Mem. Accad. Bologna, ix. p. 210).

It is probable that Herbst, under the name of *S. digitalis*, included more than one species of *Squilla*. His figure, which

seems intended for *S. mantis*, nevertheless represents the dactyli of the raptorial limbs as five-spined. In his description the dactylus is said to be five or six-spined, and the species to inhabit both the East-Indian and Adriatic seas.

*Squilla empusa.* (Pl. II. fig. 12.)

*Squilla empusa*, Say, Journ. Ac. Nat. Sci. Philad. i. p. 250 (1818); M.-Edwards, Hist. Nat. Crust. ii. p. 525 (1837); De Kay, New-York Fauna, vi. Crust. p. 32, pl. xiii. fig. 54 (1844); White, List Crust. Brit. Mus. p. 84 (1847); Gibbes, Proc. Amer. Assoc. p. 199 (1850).

This species comes so very near to *S. mantis* that I was at first inclined to regard it as merely a variety; the examples in the Museum, however, may always be distinguished by the following characters:—The lateral processes of the first thoracic segment are acute, but, instead of being straight as in *S. mantis*, are elongated and curved forward. I may add that the number of spinules between the submedian and the first lateral marginal spines of the terminal postabdominal segment are usually fewer, from five to seven in number.

*Hab.* Atlantic region.

There are in the Museum collection a young male from Rhode Island, U.S. (*T. Say, Esq.*), and a male and female from Jamaica (*R. S. Redman, Esq.*), a young female from West Africa (*Burton*), four females from the Gambia (*T. Whitfield, Esq.*), two from the Gaboon (*R. B. N. Walker, Esq.*, and *H. Ansell, Esq.*), and a male individual labelled *Squilla caribea*?, without locality, from *A. MacLeay, Esq.*

It is stated by Gibbes to be frequent in Charleston Harbour, U.S., and by Say to range as far south as East Florida.

*Squilla neglecta.*

*Squilla neglecta*, Gibbes, Proc. Amer. Assoc. vi. p. 200 (1850).

This species, described by Gibbes from specimens obtained in Charleston Harbour, South Carolina, is only distinguished from *S. mantis* in that the lateral process of the first exposed thoracic segment is not narrowed gradually to an acutely pointed termination, but its two edges are parallel and the extremity is rounded; so that it is spatuliform, and not spiniform; the median crest of the last postabdominal segment terminates posteriorly in an acute spine twice as long as in the typical *S. mantis*.

I have seen no specimens. The examination of a sufficient series might show that both this species and *S. empusa* are to be united with *S. mantis*.

*Squilla dubia.*

*Squilla mantis*, Desm. Consid. Crust. p. 250, pl. xli. fig. 2 (1825), nec auctorum.

? *Squilla dubia*, M.-Edwards, Hist. Nat. Crust. ii. p. 522 (1837); Gibbes, Proc. Amer. Assoc. vi. p. 200 (1850).

? *Squilla rubrolineata*, Dana, Crust. U.S. Expl. Exp. xiii. p. 618, pl. xli. fig. 2 (1852); v. Martens, Archiv f. Naturg. xxxviii. p. 144 (1872).

This species is nearly allied to *S. mantis*; but the rostral plate is narrowed toward and rounded at its distal end and is without a median keel. The lateral processes of the first exposed thoracic segment are straight and acute, those of the two following segments obliquely truncated and with the postero-lateral angles only subacute. The terminal postabdominal segment has the median carina and the marginal spines and spinules considerably thickened; the punctures of the upper surface are obsolete; but on either side of the median carina there is a longitudinal series of very small granules or tubercles, between the submedian spines of the posterior margin there are usually from four to six rounded tubercles or teeth, and between these and the first lateral marginal spines three or four on each side; the marginal spines of the dactyli of the large raptorial limbs are rather small, and the first or proximal spine is even occasionally obsolete. The distal prolongation of the base of the uropoda ends in two spines; and the inner spine bears a well-marked rounded tooth on its outer margin.

*Hab.* East coast of North, Central, and South America.

In the collection of the British Museum there is an adult male from St. Domingo (collected by *Mr. Tweedie*), another from Belize, Honduras (*Rev. J. Gregg*), and three others without special indication of locality (from the *Haslar Hospital collection*).

Gibbes's specimens were from Charleston Harbour, U. S., where this species appears to be rare. Von Martens records numerous specimens collected by Dr. Gundlach at Cuba, and gives some interesting particulars respecting the variation in the number of the marginal spines of the dactyli of the raptorial limbs, and of the marginal spines of the terminal postabdominal segment &c. Dana records it from Rio de Janeiro.

This is one of the few species of *Squilla* in which the spines of the dactyli of the raptorial limbs appear to vary in number. According to Von Martens, the dactyli are more frequently five- than six-spined; in only one of the Museum specimens, however, are they fewer than six-spined; and in this example the dactylus of one side has five, and of the other four spines.

*Squilla nepa*. (Pl. II. fig. 13.)

*Squilla nepa*, Latreille, Encycl. Méth. Hist. Nat. x. p. 471 (1825); M.-Edwards, Hist. Nat. Crust. ii. p. 522 (1837); White, List Crust. Brit. Mus. p. 83 (1847); Gay, Hist. Chili, Zool. iii. p. 224 (1849); Heller, Reise der Novara, Crust. p. 124 (1865); Miers, Cat. New-Zeal. Crust. p. 89 (1876).

*Squilla affinis*, Berthold, Abhandl. königl. Gesellsch. Wissensch. Göttingen, iii. p. 26, pl. iii. figs. 1, 2 (1847).

*Squilla oratoria*, De Haan, Faun. Japon. Cr. p. 223, pl. li. fig. 2 (1849); Dana, Crust. U.S. Expl. Exp. xiii. i. p. 621 (1852); Heller, Reise der Novara, Crust. p. 124 (1865).

? *Squilla Edwardsii*, Giebel, Zeitschr. f. d. gesammt. Naturwiss. xviii. p. 319 (1861).

? *Squilla lævis*, Hess, Archiv f. Naturg p. 170, pl. vii. fig. 22 (1865).

This species may be considered to represent *S. mantis* in the Indo-Pacific Region, and may be thus characterized:—The rostral plate is usually oblong, smooth above, without a median carina; the lateral margin of the carapace is not angulated in front of the postero-lateral lobe; the exposed thoracic segments and usually two or three of the anterior postabdominal segments are marked with a longitudinal median impressed line. The lateral processes of the first three exposed thoracic segments are bilobate; the anterior lobe of the first segment is elongated, curved forward, and acute; in the second and third segments the posterior lobe is the larger and acute. On the second to sixth postabdominal segments there usually exists a small median tubercle, and the first lateral carinæ are usually interrupted; the upper surface of the terminal segment is marked with shallow pits symmetrically disposed in curved lines on either side of the median keel (as in *S. mantis*); between the submedian terminal spines there are usually from six to eight, and between the submedian and first lateral spines usually seven or eight small denticles or spinules. The distal prolongation of the base of the uropoda ends in two slender elongated spines, the inner and longer of which has a small tooth or lobe on its outer margin. Length of an adult male about  $5\frac{1}{2}$  inches.

*Hab.* Indo-Pacific Region.

The series in the Museum collection includes males and females from the Indian Ocean (one from *General T. Hardwicke*), China (two from *Dr. Leach's collection*), a male and a female from Amoy, a male and two females from Shanghai (*R. Swinhoe, Esq.*), and a male from Chefoo (*R. Swinhoe, Esq.*); four males from Yokohama, Japan (*R. Batson Joyner, Esq.*), a male from Australia, Port Curtis (*H.M.S. 'Rattlesnake'*), males from the Philippines (*H. Cuming, Esq.*, and *H. J. Veitch, Esq.*), a female without precise locality (from

the collection of *H.M.S. 'Herald'*), and a male and female from Zanzibar (*Colonel Playfair*).

Besides the above localities, I may note that it has been recorded by Heller from Ceylon, Madras, Singapore, Java, Auckland, and Tahiti, as *S. nepa*, and from Ceylon as *S. oratoria*\*; from the island of Banka, by Giebel, as *S. Edwardsii*; from Sydney, by Hess, as *S. laevis*; and by Milne-Edwards and Gay from Chili.

The series before me shows that this species varies considerably in the form of the rostrum (which is sometimes more elongated and narrowed distally), of the lateral processes of the thoracic segments (which, however, are always bilobate), in the greater or less rugosity of the postabdominal segments, &c.

It would appear that the specimens referred to by Say and Gibbes as *S. mantis*, in their descriptions of *S. empusa*, belong to *S. nepa*.

In a young female from the Philippine Islands, which I at first separated as a distinct species under the name of *S. gracilis*, the dactylus of the raptorial limbs is on one side seven- and on the other eight-spined, and the lateral lobes of the bilobate fifth and sixth thoracic segments are rounded. I may observe that the appendages of the thoracic limbs are filiform and elongated, not dilated and ovate as (according to De Haan) they are in the young *Lysiosquilla maculata*. It is possible that this is after all the type of a distinct species.

\*\*\*\*\* *Dactyli of the raptorial limbs armed with seven or eight spines.*

### *Squilla armata.*

? *Squilla armata*, M.-Edwards, Hist. Nat. Crust. ii. p. 521 (1837); Gay, Hist. de Chile, Zool. iii. Crust. p. 223 (1849).

In the specimens in the Museum collection (which I refer to this species with some hesitation, on account of the brevity of the descriptions) the carapace is narrowed anteriorly, with the cervical suture very faintly defined in its posterior portion, and the lateral longitudinal carinæ obliterated, except on the postero-lateral lobes; the spine at the antero-lateral angles is small but distinct. The rostral plate is somewhat elongated and narrowed distally, with a very slight median elevation. The lateral spines of the antennular segment are prominent and curved forward; and in front of these there are two smaller spines on the ocular segment. The lateral processes of the first exposed thoracic segment are narrow, straight, and acute;

\* I do not know on what grounds Dr. Heller separated *S. oratoria* from *S. nepa*.



those of the two following segments are broader and rounded laterally, with a spinule at their postero-lateral angles. There is a small median carinule or tubercle on the third to fifth post-abdominal segments; on the fourth and fifth segments the lateral carinæ, and on the sixth segment all the carinæ end in spinules; the terminal segment is armed with a few tubercles near its base, with a longitudinal median carina, on either side of which is a lateral longitudinal series of very small tubercles; there is a rather deep median fissure between the submedian marginal spines, but no denticles; between these and the first lateral marginal spines there are on each side ten or eleven very small denticles or spinules. The distal prolongation of the base of the uropoda ends in two very unequal spines, the inner of which bears a small tooth on its outer margin. Length of the larger individual about  $5\frac{1}{8}$  inches.

*Hab.* Chili; Auckland Islands.

Two females are in the Museum collection, one of which was taken from a bottle with obliterated label, the contents of which were believed to have come from the west coast of North America; the other is from Laurie Harbour, Auckland Islands (*W. Wykeham Perry, Esq.*). The former differs from the Auckland specimen in having the rostral plate more narrowed distally and armed with a terminal spinule, and in the absence of punctulations on the terminal postabdominal segment.

II. *Penultimate joint of the large raptorial limbs armed with immobile spines along its whole length.*

*Squilla raphidea.*

*Squilla arenaria marina*, Seba, Thesaurus, iii. p. 50, pl. xx. fig. 2 (1758).

*Squilla raphidea*, Fabr. Ent. Syst. Suppl. p. 416 (1798); Latreille, Encycl. x. p. 471 (1825); Atlas (as *S. mantis*), pl. cxxiv.; M.-Edwards, Hist. Nat. Crust. ii. p. 524 (1837); White, List Crust. Brit. Mus. p. 84 (1847).

*Squilla mantis*, var. *B. major*, Lamarck, Hist. Anim. sans Vert. v. p. 187 (1818).

*Squilla harpax*, De Haan, Faun. Japon. Crust. p. 222, pl. li. fig. 1 (1849).

Carapace elongated, with a longitudinal median ridge terminating posteriorly immediately in front of the cervical suture, and with two longitudinal lateral ridges on each side between the cervical suture and the lateral margins, of which the innermost is interrupted. There is a spine at the antero-lateral angles, and at some distance in front of the postero-lateral angles a strong triangular acute lobe or tooth; the rostral plate is elongated, narrowed, and subacute at its

distal end. Each of the exposed thoracic segments is armed with six, and the postabdominal segments with eight longitudinal ridges (those of the lateral margins included), all except the submedian ridges terminating posteriorly in a spinule; on the penultimate segment the submedian ridges also terminate in small spines; the terminal segment is armed with a greatly thickened convex median dorsal ridge; the lateral and posterior margin is also greatly thickened in the adult. There are from seven to ten tubercles between each of the spines of the posterior margin; the penultimate joint of the raptorial limbs is armed with numerous immobile marginal spines, of which from five to eight are larger (besides the mobile spines at base), and the dactylus with eight very long spines. The basal portion of the uropoda is greatly produced distally, and armed with two strong spines. The length of the largest individual (a dried female, from Borneo) is somewhat over  $10\frac{1}{2}$  inches.

*Hab.* Indo-Pacific Region.

Specimens are in the Museum collection from the Indian Ocean (*General Hardwicke*), Borneo (*A. R. Wallace, Esq.*), Philippine Islands (*H. J. Veitch, Esq.*), and Zanzibar (*Dr. Kirk*). The males in the collection are of small size, and do not present any marked sexual distinctions.

De Haan records this species from the Japanese seas as *S. harpax*.

- B. The exposed thoracic and the first to fifth postabdominal segments with the dorsal surface smooth, without median tubercles or submedian carinæ. The submedian spines of the terminal segment usually furnished with a small mobile spinule at their distal ends.

\* *Dactyli of the raptorial limbs armed with five marginal spines.*

### *Squilla Desmarestii.*

*Squilla Desmarestii*, Risso, Crust. de Nice, p. 114, pl. ii. fig. 8 (1816); Hist. Nat. Eur. mérid. v. p. 86 (1826); Lamarck, Hist. Anim. sans Vert. v. p. 188 (1818); Desm. Consid. Crust. p. 251 (1825); Latreille, Encycl. Méth. x. p. 472 (1825); Roux, Crust. de la Méditerranée, livr. viii. pl. xl. (1830); Yarrell, Loud. Mag. Nat. Hist. vi. p. 230, fig. 23 (1833); M.-Edw. Hist. Nat. Crust. ii. p. 523, pl. i. fig. 1 (1837); White, List Crust. Brit. Mus. p. 84 (1847); Bell, Brit. Crust. p. 354 (1853); Heller, Crust. südl. Europa, p. 307 (1863).

Carapace smooth, without traces of longitudinal carinæ, except close to the posterior margin, and with the cervical suture obsolete in its posterior portion; no spine at the antero-lateral angles of the segments. Rostral plate oblong-oval, smooth above, and rounded at its distal end. Spines of the antennular segment small; no spines on the ophthalmic segment. First exposed thoracic segment but little laterally

produced, with the lateral angles blunt and the inferior acute; second and third segments truncated laterally, with the angles rounded. The carinæ of the fifth and sixth postabdominal segments terminating in spinules. Last postabdominal segment with a strong median carina, which is interrupted near its base and ends in a spine; upper surface armed with series of nearly confluent punctulations, which are obsolete except toward the lateral margins; there are eight or ten acuminate spinules between the submedian marginal spines, and between these and each of the first lateral spines. Inner and longer of the terminal spines of the basal prolongation of the uropoda bearing a small rounded lobe on its outer margin. Length nearly 3 inches.

*Hab.* Mediterranean (common); Channel (rare).

There are in the British-Museum collection two male examples from Nice, and a smaller male from Sicily; a male from Brighton (*Dr. Mantell*), another from Cornwall (*Mr. Laughlan*), also two males without definite locality presented by *J. B. Jukes, Esq.\**

It is remarkable that all the specimens in the Museum collection are of the male sex.

**\*\* *Dactyli of the raptorial limbs armed with six spines.***

### *Squilla fasciata.*

*Squilla fasciata*, De Haan, Faun. Japon. Crust. p. 224, pl. li. fig. 4 (1849).

This species is described by De Haan as having the carapace very convex in the middle, with the sulci distinct and produced to the posterior margin; antero-lateral angles acutely spinose. Rostral plate trigonous, narrower anteriorly. Lateral process of the first exposed thoracic segment terminating in an acute spine. Postabdominal segments gradually increasing in width, the fifth scarcely twice as broad as the first. Terminal segment sexcarinulate, the carinules alternately longer and decurrent from the base, and shorter and decurrent to-

\* No locality is given in the register for these specimens; but most of the crustaceans collected by Jukes were from the Australian seas, and that these *Squillæ* were thought to come from the same locality is evident from the label attached to one of the specimens. If the *Squilla Desmarestii* be indeed an inhabitant of these regions, it will be a fact hitherto unparalleled in our knowledge of the distribution of the group, and the more remarkable as there exists a species (*S. fasciata*) nearly allied to the *S. Desmarestii* in the Japanese region, and which, one would suppose, would be also its representative in the Australian seas.

These are the specimens referred to by Dr. Woodward (*Ann. & Mag. Nat. Hist.* 1879, ser. 5, vol. iv. p. 319) as being the nearest recent allies to his *S. Wetherelli* from the London Clay.

wards the posterior margin; the lateral spines not thickened at base. Outer margin of the dactyli of the raptorial limbs unarmed at base (not unituberculate, as in *S. Desmarestii*). Appendages of the thoracic limbs membranaceous and broadening from base to apex. Inner lobe of the base of the uropoda margined with narrow and very acute spines gradually increasing in length; inner lateral laminae linear, eight times as long as broad; outer with the first joint longer than the second.

*Hab.* Japan.

A single specimen was known to De Haan.

[To be continued.]

## II.—*Preliminary Report on the Australian Amphipoda* \*.

By WILLIAM A. HASWELL, M.A., B.Sc. Edinburgh.

A STUDY of the Amphipodous Crustacea of Australia during the last few months has revealed features of special interest in that department of the southern marine fauna. The field of research has been almost entirely untouched; for, though Milne-Edwards †, Dana ‡, Stimpson §, and Spence Bate || have described a few Australian forms, the total number of species hitherto known amounts only to thirteen—these being chiefly Orchestidæ, the few Gammaridæ described not including any of the forms which must be regarded as peculiarly Australian.

Between the amphipodous fauna of Temperate Australia as exemplified in Port Jackson and that of tropical Queensland a well-marked dividing-line may be drawn. In temperate latitudes on the Australian coast littoral and circumlittoral Algæ are extremely abundant and varied in sheltered situations, giving, with the numerous varieties of sponges and phytoid Polyzoa, a well-marked facies to the shallow-water life of these shores, and affording ample feeding-grounds and lurking-places for myriads of edriophthalmous Crustacea. It is here that the characteristic Australian forms are to be found. Within the tropics, on the other hand, Algæ are

\* Descriptions and figures of the new species will appear in the 'Proceedings of the Linnean Society of New South Wales' for the present year.

† 'Histoire Naturelle des Crustacés,' tom. iii. (1837).

‡ 'Proceedings of the American Society of Natural Science, Boston,' vol. ii.; and 'Crustacea of the U.S. Exploring Expedition.'

§ 'Proceedings of the Academy of Natural Sciences of Philadelphia (1855).

|| 'Catalogue of Amphipodous Crustacea' (1862).

comparatively few; and even where they occur in considerable masses (as is the case on the dead parts of coral reefs with certain fucoids) their edriophthalmous inhabitants are not numerous, and belong, so far as at present ascertained, to cosmopolitan genera—the species being, in many cases, identical with those of the temperate zone. Amongst living coral but few Amphipoda or Isopoda are to be found; and the use of the dredge at various depths in the neighbourhood of the coral reefs did not produce a large variety of forms; the Orchestidæ, however, are quite as abundant on sandy and stony beaches in the tropics as in temperate latitudes. The following is a summarized account of the species observed:—

A species of *Talitrus* inhabits damp woods and scrubs in New South Wales and Tasmania, being found in the former colony at least thirty miles from the sea; and another occurs under dead wood and leaves in the mangrove-swamps of tropical Queensland. Species of *Talorchestia*, *Orchestoidea*, *Orchestia*, and *Allorchestes* are abundant on the shores of Tasmania, New South Wales, and Queensland.

A species of *Stegocephalus* (*S. latus*), broader and higher than the Arctic species, and distinguished from it in various other particulars, is found in Tasmania.

A remarkable new form, which I have named *Cyproidea*, from its superficial resemblance to a Cyprid, is represented by two species found in Port Jackson. It is characterized by the possession of deep lateral shields, formed not, like the corresponding though much smaller structures in the sub-family *Stegocephalides* (Spence Bate), by the coxæ of the second gnathopoda and first and second pereopoda, but by those of the first and second pairs of pereopoda alone, these being enormously expanded, extending forwards to the sides of the cephalon and backwards nearly to the level of the posterior limit of the pereion, concealing the inconspicuous coxæ of the gnathopoda, and excavated above and posteriorly for the reception of the shallow amalgamated coxæ of the third and fourth pairs of pereopoda, the coxæ of the last pair of pereopoda remaining rudimentary. These shields almost conceal the gnathopoda and all but the tips of the pereopoda, and are variously ornamented with coloured dots and lines in the two species. The antennæ are simple and subequal; the mandibles palpigerous; the maxillipedes unguiculate and armed with small squamiform plates; the gnathopoda subchelate (*complexly* in one species, *simply* in the other); the posterior pleopoda biramous, and the telson simple.

Another characteristic genus is one which I have named

*Amaryllis*, represented by a species in Tasmania and another in Port Jackson. It has the coxæ of the second pair of gnathopoda and of the first and second pairs of pereopoda expanded as in *Stegocephalus*, *Pleustes*, and allied genera, but differs from all of them in combining the possession of appendiculate superior antennæ with palpigerous mandibles and biramous foliaceous posterior pleopoda.

The genus *Lysianassa* is represented by several species in Port Jackson (where it is very abundant in certain situations) and Port Denison.

Allied to *Lysianassa* is a new genus (*Glycera*) represented by a species common to North Australia (Howick group of islands) and Port Jackson. It is characterized by having the four anterior pairs of coxæ very deep, as in *Lysianassa*, *Anonyx*, and other genera of the subfamily *Lysianassides* of Spence Bate, but possesses longish slender (appendiculate) superior antennæ; the mandibles are palpigerous; the maxillipedes possess well-developed squamiform processes, as in *Lysianassa*; the gnathopoda are slender and filiform; the posterior pleopoda are biramous; and the telson is double.

A species of *Ampelisca* occurs in Port Jackson and Port Denison, together with two species of *Phoxus*. A species of *Ædicerus* and one of *Urothoë* occur on the sandy beach at Bondi, near Sydney. The genera *Pherusa* and *Atylus* are both represented, the latter by several species. Of the genus *Leucothoë* several species from Tasmania, New South Wales, and Queensland have the gnathopoda formed upon the same type as the European *L. articulosa* and the American *L. grandimana*, whilst another approaches more nearly in that respect to *L. furina*. These species are almost always found in the interior of sponges, or in the pharyngeal and atrial cavities of various ascidians.

Species of the cosmopolitan genera *Melita*, *Megamæra*, *Mæra*, and *Gammarus* occur abundantly—the common species of the first of these, which I have named *Melita australis*, being a very close ally of the North-African *M. anisochir*.

A species of *Eusirus*, distinguished by the spinous anterior pleonal segments, occurs in Tasmania.

Probably nearly related to *Eusirus* and *Iduna* is a new generic form which I have named *Macleayia*. It has the superior antennæ appendiculate, shorter than the inferior pair; the mandibles are provided with an appendage; the maxillipedes are exunguiculate, with the squamiform processes rudimentary; the gnathopoda are subchelate, the posterior pair being very large; the posterior pleopoda have one large ramus; and the telson is small and undivided.

Another new genus, *Polycheria*, is represented by two species found in Port Jackson. It has the pereion broad, the pleon compressed and carinate; the antennæ are of nearly equal size, with long slender flagella, the superior pair being devoid of secondary flagellum; the mandibles are exappendiculate; the maxillipedes possess well-developed squamiform processes; the gnathopoda are subchelate, small; the pereopoda are slender, and have all prehensile terminal joints; the posterior pleopoda are biramous; and the telson is double. *Polycheria* would belong to Dana's subfamily *Isœanæ*, but has little in common with *Isœa* save the prehensile pereopoda.

In *Chloris* (mihi) the antennæ are well developed, the superior pair shorter than the inferior and provided with an appendage; the mandibles are palpigerous; the maxillipedes unguiculate, subpediform, provided with a squamiform process on the basal joint only; the gnathopoda are subchelate, unequal, the second pair being very large; the posterior pleopoda are biramous, with short, conical rami; and the telson is single and elongate.

Several species of *Microdeuteropus* occur in Port Jackson, one of them having a close relationship to *M. Websterii*, another to *M. gryllotalpa*, and a third to *M. anomalus*, while a fourth appears to have no precise homotype among northern species.

A new form allied to *Microdeuteropus* I have named *Xenochœira*. It is distinguished by the remarkable form of the posterior gnathopoda, the carpus of these organs being broad and plate-like, projecting anteriorly, and articulating in an unusual manner with both ischium and meros; the superior antennæ are long and appendiculate, the inferior shorter; the mandibles are provided with an appendage; the maxillipedes possess squamiform processes; the gnathopoda are non-subchelate, and armed with long, close fringes of hairs; the posterior pleopoda are biramous; and the telson is simple.

Allied to Krøyer's genus *Protomedeia*, but distinguished from it by the short exappendiculate superior antennæ and the simple anterior gnathopoda, is a new generic form which I have named *Haplocheira*, represented by a species found in Port Jackson.

The genus *Amphithoë* is common on the Australian coast, several of the species being found both in Port Jackson and in Port Denison; *Podocerus* also occurs in the former locality, together with three species of *Cyrtophium*, and one (or perhaps two) of Dana's remarkable aberrant genus *Idilius*.

Among the Corophiidae, a curious form obtained with the dredge in Port Jackson appears to belong to the genus de-

scribed by Grube (Archiv für Naturg. Band i. p. 201) under the name of *Colomastix*. It has stout, simple, subequal antennæ, with rudimentary flagella, like those of *Cratippus*; the anterior gnathopoda are long, filiform, and exungiculate in both sexes, while those of the posterior pair are large and subchelate; the posterior pleopoda are biramous with unequal rami; and the telson is single and pointed. This peculiar form shows an approximation to *Cratippus* and *Siphonæcetus* in the structure of the antennæ, but differs from both these genera in the form of the anterior gnathopoda and of the posterior pleopoda; from the allied genera *Podocerus*, *Corophium*, *Dryope*, and *Unciola* it is separated by the character of the antennæ and of the anterior gnathopoda.

### III.—On the Terms *Bryozoa* and *Polyzoa*.

By ARTHUR WILLIAM WATERS, F.G.S.

I HAVE already\* given my reasons shortly for calling this group *Bryozoa* instead of *Polyzoa*; but it seems advisable to call attention to this point again more fully.

The argument upon which those who have adopted the name *Polyzoa* have relied has been that Thompson had priority over Ehrenberg. This does not appear to be disputed, and seems to have been a side wind which has prevented zoologists from examining Thompson's paper, thinking it was a question of dates; but I have pointed out that Thompson did not in his paper indicate any group of animals by his term, and that all he meant by *Polyzoa* was a single polypide. It is apparent he here made an etymological mistake, as also in using the plural *Polyzoæ*; but with this we have nothing to do, and I do not urge this as any reason against his term, but confine myself to the meaning he applied.

We do not need to go further than the title, which is, "*On Polyzoa, a new animal discovered as an inhabitant of some Zoophytes.*" I ask, does this in the least express our present ideas? Further on (p. 97) he says, "the other species of *Sertularia* in which the animals have been determined to be *Polyzoæ*;" and this same idea of the inhabitants of the zoophytes being *Polyzoæ* is expressed every few lines.

I feel the greatest confidence that as soon as zoologists generally know that this is no bibliographical question of dates, and themselves turn to Thompson's paper, they will see

\* "On *Bryozoa*," Manch. Lit. & Phil. Soc., Microsc. & Nat. Hist. Sect. 1878, vol. xvii.



they have been induced to use the name *Polyzoa* under a misapprehension.

There is another argument which has been brought forward very recently by Prof. T. Rupert Jones\*, who points out that Ehrenberg included animals under *Bryozoa* which are now known not to be correctly so placed. This requires us to turn and see what Ehrenberg says; but we may first remark that we suppose Prof. Rupert Jones found the general reason of priority so insufficient that he saw he must find the polyzoists a better reason than they had themselves discovered. I should like to know if they acknowledge this new argument or say it need not have been given. If they do not ignore Prof. Jones's 'Geology of Sussex' and thank him for his support, this is what, in polite diplomatic language, would be called a change of front, but which we prefer to consider a retreat.

Did Ehrenberg describe the *Bryozoa* as a group? In 'Symbolæ Physicæ' he has "circulus I. Anthozoa," and, divided from this, "circulus II. Bryozoa," which he separates thus:—"ore anoque distinctis, tubo cibario perfecto. (Vibratio aperta ciliorum ope; an omnibus? Ovipara et gemmipara, sponte nunquam dividua.)" And in 'Die Corallenthiere d. Rothen Meeres' he similarly divides them; and the "doppel-mündige Corallenthiere" or *Bryozoa* he defines "mit einem kammerigen, innen nicht strahligen Körperbaue, besonderem Mund und After, oft bewimperten wirbelnden Fangarmen." And his families are *Cristatellina*, *Halcyonellea*, *Cornularina*, *Escharina*, *Celleporina*, *Auloporina*, *Antipathina*, *Myriozoina*.

*Cornularia* is, I suppose, a *Hydrozoon*; and *Antipathes* and *Aulopora* are *Actinozoa*; but because he did not fully understand these three, this is no reason for saying he did not establish the *Bryozoa* as a group; for in how many groups animals have been placed in error! *Anthozoa* has had many strangers; or, forsooth, *Millepora*! what has it not included?

The type of Ehrenberg is *Alcyonella*; and he says, in 'Symbolæ Physicæ,' "*Alcyonellæ hujus Circuli typum referre videntur*," and, further on, "*Flustræ enim et Sertularina ex meis observationibus neque Ascidiis compostis nec Hydra similia videntur sed Alcyonellis*." He then describes *Zoobotryon pellucidus*, a clearly marked and easily studied species.

It is true he included in mistake *Antipathes*; but he does not seem to have been quite sure, and says (*loc. cit.*), "*Eidem Circulo Flustras et Sertularina nonnulla, forsan omnia, quin imo Antipathes genus subjugenda esse censeo*."

\* 'Geology of Sussex,' Dixon and Jones (Brighton, 1878).

Prof. Jones alludes to Polythalamia being included; but I cannot find any case or see any indication of this in 'Die Corallenth. d. R. Meeres;' but some of the larger Foraminifera, as *Polytrema*, have been taken for Bryozoa quite recently, as by Risso, Heller, and others. Such mistakes will be made until our faunas have been more fully investigated; and it is a matter of surprise that Ehrenberg included so few extraneous genera among his Bryozoa.

A friend, writing to remonstrate with me for using the term Bryozoa in a paper I recently wrote, says "group names are indications of advancing scientific knowledge; and not to use the best is to keep science back." In this I agree, but think that the comparison of Ehrenberg's exacter definitions and Thompson's imperfect conceptions must leave us fully convinced that in Ehrenberg we have the clearest proof of advancing knowledge.

If Thompson's name stood alone, of course, no one would question it; but as the two names are in use, we have to decide between them. D'Orbigny, Hagenow, Bronn, Van Beneden, Reichert, Reuss, Nitsche, Kirchenpauer, Smitt, Römer, Claparède, Manzoni, Ehlers, Barrois, Joliet, and many others have all used Ehrenberg's term, against which are a few polyzoists, all, except Sars, in England and America, some of whom certainly occupy most leading positions; but it should not be forgotten that even in England the use of the name Polyzoa is comparatively a recent innovation.

The points to be considered are:—(1) that the question is not one of dates; (2) that Thompson did not define any group of animals, and used Polyzoa to indicate only a polypide; (3) that Ehrenberg definitely separated the Bryozoa, and, considering how little attention they had then received, was very successful in the indications he gave as to which animals belonged to this group.

La Stazione Zoologica, Naples,  
Nov. 14, 1879.

#### IV.—On the Genera of Felidæ and Canidæ.

By E. D. COPE \*.

##### Felidæ.

THE discovery of extinct species from time to time renders it necessary to reexamine the definitions of the families and genera into which living forms naturally fall. We thus learn

\* From the 'Proceedings of the Academy of Natural Sciences of Philadelphia,' May 1879.

the characters of their primitive types, and the successive steps through which they passed in attaining their present characteristics. The Felidæ are known as that family of Carnivora in which the feet and teeth are most specialized for the functions of seizing and lacerating living prey. The number of living species enumerated by Dr. Gray is sixty-four, which he throws into a number of genera. The extinct species yet known are less numerous, but they present a greater variety of structure than the former. Two types or series may be recognized among the genera, namely those represented by the genera *Felis* and *Machærodus* respectively. All of the latter are extinct.

The greater number of the genera allied to *Machærodus* are distinguished by the great development of the superior canine teeth, whose crowns are generally compressed and trenchant. The corresponding part of the mandible is expanded downwards so as to furnish a protection to the slender crown from fracture by lateral blows when not in use; but in some of the genera, e. g. *Nimravus*, this flange is not developed. The only definition which can be used to distinguish these sections of the family is found in the angular separation of the anterior and lateral planes of the ramus of the mandible; and this character cannot be expected to remain unaffected by future discovery. Forms will doubtless be found in which the angle is obsolete and in which the lateral and anterior faces pass gradually into each other. Other characters which distinguish the extinct genera are found in the number of molar teeth, and, what has been heretofore neglected, the number of lobes of the molars themselves.

As regards the existing genera, Dr. Gray\* has brought out their characters more fully than any other author. He points out the fact that in some of the species the orbits are closed behind, and in others open. He first examined into the manner of the contraction and closing of the pupil in the presence of light, and pointed out the fact that in the large cats it is always round and approximates to a point in closing, while in the smaller forms the pupil closes as a vertical slit. He shows that the cats of the former group have the smaller orbits of the cranium, and the latter the larger. Dr. Gray, however, uses other characteristics in the discrimination of the genera, which are, in my estimation, quite inadmissible—as the relative length of the muzzle and of the premaxillary bones, also of the hair on different parts of the body and tail.

\* Catalogue of Carnivorous, Pachydermatous, and Edentate Mammalia in the British Museum. By John Edward Gray, F.R.S., V.P.Z.S., F.L.S., &c. London, 1869.

Such features of proportion are essential as characters of species, but not of genera. In accordance with these views I have united several of Dr. Gray's divisions into groups which I call genera, and which repose on some definite structural characters. Thus I combine his *Uncia*, *Tigris*, *Leo*, and *Leopardus* into a genus for which I employ his name *Uncia*, as the least objectionable\*, after having confirmed by autopsy the circular character of the pupil. This I was enabled to do through the courtesy of my friend Arthur E. Brown, superintendent of the Philadelphia Zoological Garden, who aided me in examining the eyes of these animals both by sunlight and the light of a bull's-eye lantern†. The detailed characters of the genera will now be given:—

I. The anterior and lateral faces of the mandible separated by an angle.

a. Inferior sectorial with a heel; no anterior lobe of superior sectorial; no posterior lobes of the premolars.

\* An inferior tubercular molar.

Premolars  $\frac{2}{3}$  ..... *Dinictis*.

Premolars  $\frac{2}{2}$  ..... *Nimravus*.

\*\* No inferior tubercular molar.

Premolars  $\frac{2}{2}$ ; incisors  $\frac{3}{3}$  ..... *Hoplophoneus*.

Premolars  $\frac{2}{1}$ ; incisors  $\frac{2}{2}$  ..... *Eusmilus*.

aa. Inferior sectorial without heel; an anterior lobe of the superior sectorial, and posterior lobes of the premolars.

Premolars  $\frac{2}{2}$ , first inferior two-rooted ..... *Machærodus*.

Premolars  $\frac{2}{2 \text{ or } 1}$ , first inferior one-rooted ..... *Smilodon*.

II. The anterior and lateral faces of the mandible continuous, convex. (No inferior tubercular molar.)

a. Inferior sectorial tooth with a heel.

Premolars  $\frac{2}{4}$ , no posterior lobes; second superior with internal heel (plantigrade) ..... *Cryptoprocta*.

Premolars  $\frac{2}{2}$ , with posterior lobes; no heel of second superior ..... *Pseudelurus*.

aa. Inferior sectorial without heel; premolars with posterior lobes; superior sectorial with anterior lobe.

β. Superior sectorial with internal heel.

γ. Pupil round.

Premolars  $\frac{2}{2}$  ..... *Uncia*.

Premolars  $\frac{1}{2}$  ..... *Neofelis*.

\* I assume that this name is derived from *uncus*, a hook, which is appropriate to the weapons of these animals. [*Felis uncia* was the name given by Gmelin to the Ounce; and no doubt Dr. Gray simply adopted its specific name for the genus of which he regarded it as the type. Its use in a more extended sense is therefore unfortunate.—ED.]

† I add the following notes on some other Carnivora, which do not come within the scope of this paper:—

*Hyæna crocuta*. Pupil a vertical slit.

Viverridæ. Three species of *Ichneumon* and *Viverricula*, a horizontal oval.

*Nasua*. A horizontal oval.

γγ. Pupil vertical.

Orbit closed behind; premolars  $\frac{2}{2}$  ..... *Catolynx*.

Orbit open; premolars  $\frac{2}{3}$  ..... *Felis*.

Orbit open; premolars  $\frac{1}{3}$  ..... *Lyncus*.

ββ. Superior sectorial without internal heel.

Pupil round, premolars  $\frac{2}{2}$ , orbit open posteriorly. *Cynælurus*.

The following catalogue includes the species of the Felidæ, the names of the recent ones being derived from Gray's Catalogue and printed in Roman letters. These are probably too numerous in the genera *Felis* and *Lyncus*; but I do not possess the means of properly disposing of them.

DINICTIS, Leidy. *Ælurogale*, Filhol. ? *Daptophilus*, Cope.

*D. intermedia*, Filhol. Phosphorites, France.

*D. squalidens*, Cope. White River, Colorado.

*D. felina*, Leidy. White River, Nebraska.

*D. cyclops*, Cope. White River, Oregon.

NIMRAVUS, Cope.

*N. brachyops*, Cope. White River, Oregon.

HOPLOPHONEUS, Cope.

*H. primævus*, Leidy. White River, Nebraska.

*H. occidentalis*, Leidy. White River, Nebraska.

EUSMILUS, Gervais.

*E. bidentatus*, Filhol. Phosphorites, France.

MACHÆRODUS, Kaup. *Agnotherium*, Kaup. *Drepanodon*, Nesti.

*M. palmidens*, Blv. Falunian, Sansan.

*M. ogygius*, Kaup. Cœningian, Eppelsheim.

*M. antiquus*, Nesti. Pliocene, Italy, France.

*M. Falconeri*, Pomel. Upper Miocene, India.

*M. cultridens*, Cuv. Pliocene, Europe.

*M. latidens*, Owen. Pliocene, England.

*M. aphanista*, Kaup. Cœningian, Eppelsheim.

*M. maritimus*, Gerv. Pliocene, Montpellier.

SMILODON, Lund.

*S. neogæus*, Lund. Pliocene, Brazil.

*S. necator*, Gervais. Buenos Ayres.

CRYPTOPROCTA, Bennett.

*C. ferox*, Bennett. Madagascar.

## PSEUDÆLURUS, Gervais.

- P. hyænoides*, Lartet. Falunian, Sansan.  
*P. intrepidus*, Leidy. Loup River, Nebraska.  
*P. Edwardsi*, Filhol. Phosphorites, France.  
*P. ? intermedius*, Filhol. Phosphorites, France.  
*P. sivalensis*, Lydekker.

CATOLYNX, Gray. *Viverriceps*, Gray.

- C. marmoratus*, Martin. India, Borneo.  
*C. Charltoni*, Gray. Nepal, Darjeeling (*Charlton*).  
*C. viverrina*, Bennett. East Indies.  
*C. planiceps*, Vig. & Horsf. Malacca, Sumatra, Borneo.  
*C. Elliotti*, Gray. Madras.  
*C. rubiginosa*, I. Geoff. India, Madras.

FELIS, Linn. *Pardalina*, *Felis*, and *Chaus*, Gray.

- F. pardalis*, L. America, tropical or subtropical.  
*F. grisea*, Gray. Guatemala.  
*F. melanura*, Ball. America.  
*F. picta*, Gray. Central America.  
*F. pardoides*, Gray. Tropical America.  
*F. macroura*, Pr. Max. de Wied. Brazil.  
*F. mitis*, F. Cuv. Mexico? Paraguay?  
*F. tigrina*, Schreb. South America.  
*F. Geoffroyi*, D' Orb. South America.  
*F. colocola*, Molina, South America, Chili (*Molina*), Surinam (*H. Smith*).  
*F. jaguarondi*, Lacép. South America.  
*F. eyra*, Desm. Tropical America.  
*F. serval*, Schreb. South and West Africa.  
*F. rutila*, Waterhouse. Sierra Leone.  
*F. neglecta*, Gray. Gambia.  
*F. servalina*, Ogilby. Sierra Leone.  
*F. celidogaster*, Temm. Guinea.  
*F. senegalensis*, Lesson. Senegal.  
*F. minuta* (pars), Temm. Sumatra.  
*F. javanensis*, Horsf. Java.  
*F. nepalensis*, Vig. & Horsf. India. (Perhaps a hybrid or domesticated.)  
*F. chinensis*, Gray. China.  
*F. pardinoides*, Gray. India (*Capt. Junes*).  
*F. pardochroa*, Hodgson. Nepal (*Hodgson*). Tenasserim (*Packman*).  
*F. tenasserimensis*, Gray. India, Tenasserim (*Packman*).  
*F. Jerdoni*, Blyth. Indian Peninsula, Madras.

- F. Herscheli*, *Gray*. India, "Zanzibar" ?  
*F. wagati*, *Elliot*. India.  
*F. caligata*, *Temm*. Africa, North, South, Central, and East.  
*F. inconspicua*, *Gray*. India. (Domesticated or perhaps a variety.)  
*F. domestica*, *Brisson*. Syria? (Domesticated in most countries.)  
*F. manul*, *Pallas*. Thibet.  
*F. catus*, *L*. Europe.  
*F. megalotis*, *Müller*. Timor.  
*F. himalayana*, *Gray*. Himalaya (*Cross*, *Warwick*).  
*F. Jacquemonti*, *I. Geoffr*. Africa and Asia.  
*F. ornata*, *Gray*. India (*Capt. Boys*).  
*F. catolynx*, *Pallas*. Nepal (*Hodgson*).

LYNCUS, Raf. *Pajeros*, *Lynx* et *Caracal*, *Gray*.

- L. pajeros*, *Desm*. South America. The Pampas.  
*L. borealis*, *Gray*. Northern Europe, Sweden.  
*L. canadensis*, *Geoffr*. North America.  
*L. pardinus*, *Temm*. Southern Europe, Turkey.  
*L. isabellinus*, *Blyth*. Thibet.  
*L. rufus*, *Güldenst*. North America.  
*L. maculatus*, *Vig. & Horsf*. North America, Mexico, and California.  
*L. caracal*, *Schreb*. Southern Asia and Africa, Persia and Arabia.

NEOFELIS, *Gray*.

- N. macrocelis*, *Temm*. Himalaya (*Hodgson*), Malacca.  
*N. brachyurus* (*Temm*). Siam (*Swinhoe*), Formosa (*Swinhoe*).

UNCIA, *Gray*, *Cope* emend. *Leo*, *Tigris* et *Leopardus*, *Gray*.

- U. concolor*, *L*. North and South America.  
*U. auratus*, *Temm*. Himalaya, Sumatra, Borneo.  
*U. onca*, *L*. South America, Mexico, Texas.  
*U. chinensis*, *Gray*. Pekin, mountain-forests of the west.  
*U. japonensis*, *Gray*. Japan.  
*U. pardus*, *L*. Southern Asia, North, South, and West Africa.  
*U. tigris*, *L*. Asia.  
*U. leo*, *L*. Africa, India.  
*U. irbis*, *Ehr*. Thibet.

CYNÆLURUS, Wagler. *Gueparda*, Gray.

*C. jubatus*, L. Africa, Asia, Persia, Cape of Good Hope.  
? *C. ferox*, Leidy (*Ælurodon*). Loup River, Nebraska.

The successive order of the modifications of structure which define the above genera is not difficult to perceive; and it is interesting to discover that, as in other cases, it coincides with the succession in geologic time. The typical genera *Uncia*, *Felis*, &c. are characterized by great specialization; and it is they which now exist. The oldest found, *Dinictis*, *Nimravus*, &c., are the least specialized in most respects, and they disappeared before the close of Miocene time.

Since one of the special characters of the Felidæ is the reduction in the number of the molar teeth by subtraction from both ends of the series, an increased number of these constitutes resemblance to other families. The genus *Dinictis*, above defined, has been shown by Leidy to possess two more inferior molars than *Felis*, or three more than *Neofelis* and *Lynx*, as in the Mustelidæ. The extinct *Pseudælorus* and the living *Cryptoprocta* have but one molar less than *Dinictis*, lacking the posterior tubercular. *Nimravus* has the same number of molars as *Pseudælorus*, but lacks the first premolar instead of the last true molar. In *Hoplophoneus* we first find the number of molars as in the existing genera, viz. pm.  $\frac{3}{2}$ , m.  $\frac{1}{1}$ . Other characters of this genus, however, are of a generalized kind.

I here recall the statement that the genera of Felidæ fall into two series, which are distinguished by the forms of the anterior part of the mandibular rami, and generally by the large size of the canine teeth, to which the former are adapted. This distinction appeared early in Miocene or Oligocene time—in fact, in the oldest of the cats of which we have any knowledge. The genera with large canines, or Machærodontine line, were then represented by *Dinictis*, and the Feline line by *Pseudælorus*. It is interesting to observe that these genera differed from their latest prototypes in the same way, viz.:—(1) in the presence of more numerous inferior molars; (2) in the presence of a heel of the inferior sectorial; (3) in the absence of an anterior cusp of the superior sectorial. In the case of *Dinictis* one other character of primitive Carnivora may be noticed, viz. the absence of the cutting-lobes on the posterior edges of the superior and inferior premolars, so distinct in the existing cats. The same feature characterizes the superior premolars of *Pseudælorus*; but the inferior premolars have the lobes.



In the existing *Cryptoprocta*, which Gervais has shown to be nearly allied in dentition to *Pseudaelurus*, the lobes are wanting from both jaws; but this genus adds to this primitive character another of modern significance, viz. the presence of the anterior cusp of the superior sectorial. Moreover *Cryptoprocta* has another peculiarity, which recalls the genera of the Eocene Creodonta, in the well-developed interior tubercle of the third premolar, a character unknown in Miocene or existing Carnivora. That genus is evidently, like the Lemuridæ (also of Madagascar), a remnant of the Eocene fauna, which once covered most of the earth, and may be regarded as, on the whole, the most primitive of the Felidæ, recent and extinct.

Following the two lines of Felidæ already indicated we attain the same conclusion in both, by the same stages. The primitive form of the Machærodont line, represented by *Hoplophoneus*, has its extreme in *Eusmilus*, where the second inferior premolar and an incisor tooth are wanting, giving a formula of I. 2, C. 1, Pm. 1, M. 1. In *Machærodus* we have the modern characters of the molars seen in *Felis*, viz. no heel of the inferior sectorial, the superior sectorial with an anterior lobe, and posterior lobes of the premolars. The extreme of this line is reached in *Smilodon*, where the second inferior premolar is one-rooted or wanting. This genus, then, stands related to *Machærodus* as *Eusmilus* to *Hoplophoneus*. In the Feline line proper, on reaching the existing genera, we have lost the heel of the inferior sectorial and gained the posterior lobes of the premolars and anterior lobe of the superior sectorial at once. A further modification of the dentition of the superior series of the recent forms is seen in the loss of the first superior premolar in *Lyncus* and *Neofelis*. Still another, which is one step beyond what is known in the Machærodont line, is the loss of the interior tubercle of the superior sectorial, which characterizes the genus *Cynælurus*. A superior sectorial tooth having the character of that of this genus was discovered by Dr. Hayden in the Loup-River formation of Nebraska, and was referred to a species by Dr. Leidy under the name of *Ælurodon ferox*. It was much larger than the *C. jubatus*.

As already remarked, the genera of the Machærodont line are extinct, and this in spite of the fact that they presented the most perfect weapons of destruction in their canine teeth from the earliest times. Their other modifications of structure advanced *pari passu* with those of the Feline series; and, among others, the feet presented, in the later forms at least (e. g. *Smilodon necator*, Gerv.), the most perfect prehensile

power of the lions and tigers of to-day. As nothing but the characters of the canine teeth distinguishes these from the typical felines, it is to these that we must look for the cause of their failure to continue. Prof. Flower's suggestion appears to be a good one, viz. that the length of these teeth became an inconvenience and a hindrance to their possessors. I think there can be no doubt that the huge canines in the *Smilodons* must have prevented the biting off of flesh from large pieces, so as to greatly interfere with feeding and to keep the animals in poor condition. The size of the canines is such as to prevent their use as cutting instruments, excepting with the mouth closed; for the latter could not have been opened sufficiently to allow any object to enter it from the front. Even were it opened so far as to allow the mandible to pass behind the apices of the canines, there would appear to be some risk of the latter's becoming caught on the point of one or the other canine, and forced to remain open, causing early starvation. Such may have been the fate of the fine individual of the *S. neogæus*, Lund, whose skull was found in Brazil by Lund, and which is familiar to us through the figures of De Blainville, &c.

#### DESCRIPTION OF NEW SPECIES.

##### *Dinictis cyclops.*

The species of *Dinictis* differ in the proportions of their anterior molar and canine teeth as follows:—

- |   |                         |
|---|-------------------------|
| First inferior molar one-rooted; first superior molar two-rooted; superior canine short, robust; large. | <i>D. intermedia</i> *. |
| First inferior molar one-rooted; superior canine compressed; two inferior incisors .....                | <i>D. squalidens.</i>   |
| First inferior molar two-rooted; first superior molar one-rooted; canine long, compressed .....         | <i>D. cyclops.</i>      |
| First molar of both jaws two-rooted; canine long, compressed .....                                      | <i>D. felina.</i>       |

In *D. cyclops* the first superior molar is rudimental, and will probably be found to be wanting in some specimens. The second premolar has a distinct anterior tubercle on the inner side, a character not seen in *D. felina*; the anterior angle of the superior sectorial is more produced than in that species. The crown of the superior tubercular looks partly inwards, is rather long, and has three roots. The superior canine is quite long, and has a regularly lenticular section, without facets; its anterior and posterior edges are denticulate. The external incisors are much larger than the internal, and have subconic crowns. The crowns of the

\* *Elurogale intermedia*, Filhol.

others are subcuneiform. The inferior canines are considerably larger than the incisors. The latter are regular and do not overlap each other; the second and third inferior premolars have well-developed basal lobes anteriorly and posteriorly. The heel of the sectorial is well developed. The tubercular is very small.

The form of the skull is short and wide; the zygomata are much expanded; and the profile is very convex. The muzzle is short, and the orbits are rather large. The interorbital region is wide and convex; and the postorbital processes are robust, acuminate, and directed downwards. The infraorbital foramen is very large. The apices of the premaxillary bones are elongate, but do not reach the frontals. The nasals are rounded posteriorly. The sagittal crest is prominent, and theinion elevated. The posttympanic process is short; and the paroccipital is short and is directed backwards. The cranium is constricted behind the orbits. The mandibular ramus is low posteriorly; and the anterior inferior flange is well developed, but not large.

*Measurements.*

	metre.
Length of skull on base.....	·140
Width of skull, measured below.....	·111
Length of palate.....	·060
Width of palate between posterior angles of sectorials.....	·062
Width of palate between canines.....	·026
Length of skull to front of orbits (axial).....	·050
Vertical diameter of orbit.....	·031
Interorbital width (least).....	·045
Elevation of inion from foramen.....	·032
Length of inferior molar series.....	·050
Length of inferior sectorial.....	·018
Length of base of inferior first premolar.....	·055
Depth of ramus at sectorial.....	·016
Depth of ramus at first premolar.....	·021
Depth of ramus at flange.....	·026

From the Truckee beds of John Day River, Oregon.

[To be continued.]

V.—*On the Geological Distribution of the Rhabdophora.*

By CHARLES LAPWORTH, F.G.S. &c.

Part II. DATA.

[Continued from vol. iv. p. 431.]

SILURIAN SYSTEM (*Upper Silurian of Murchison*).

Of the many suggested modifications of Murchison's latest

scheme of classification of the Lower Palæozoic rocks not one is perhaps more important, or more certain eventually to be adopted by geologists in general, than the transference of the theoretical line of demarcation between his Lower and Upper Silurian from the middle of the Lower Llandovery to the base of that formation. The immediate adoption of this new divisional line by those who rely more especially upon marked physical evidence is hardly to be expected. In the typical district of Llandovery Murchison's plan of classification appears at first sight the only one possible, as there seems to be an uninterrupted sequence from the Llandeilo into the Lower Llandovery. Not only so, but the magnitude of the stratigraphical discordance below the *Pentamerus*-Grits and Limestones of the Upper Llandovery, where Murchison draws his line of demarcation, is clear and unequivocal from Wenlock to Llangadock.

On the other hand, however, the Lower Llandovery grits, which, in Central Wales, follow immediately upon the dark shales of the Upper Bala, afford unmistakable evidence of important and widespread changes in the physical condition of the sea-bottom at the advent of the Llandovery epoch. Even in the typical district of Llandovery itself this change, according to Messrs. Salter and Aveline, is, probably, marked by an unconformability. Throughout the basin of the Dee the Lower Llandovery beds, according to the most recent researches of Professor Hughes and others, retain their coarse arenaceous character. The relations of the Bala shales to similar grits at Conway appear to me impossible of interpretation except on the hypothesis of an unconformability or overlap at the base of the latter. The most convincing argument, however, in favour of the proposed change is found in the fact that, if we except the typical district of the higher portion of the valley of the Towey, the most distinct physical and palæontological break in the strata that lie between the Arenig and the Ludlow is that at the summit of the Bala formation and its extra-British equivalents. In Scotland, for example, the only palæontological break of any magnitude is that at the base of the equivalent of the Lower Llandovery—the representatives of the Lower Llandovery, Upper Llandovery, and Tarannon graduating imperceptibly the one into the other. In Scandinavia the same rule holds good generally, though there are beds of passage where the Ordovician and Silurian forms are for a time commingled. I believe that the same rule obtains in Bohemia and Thuringia; but our present evidence is too defective to enable us to bring forward decisive proofs. In America (Anticosti ex-

cepted) the physical and palæontological changes at the base of the equivalents of the Lower Llandovery are so marked and of such systematic importance, that American geologists have universally drawn the boundary line between their Lower and Upper Silurian systems along this horizon.

Adopting, then, this line as the base of the true Silurian, we have next to determine the most natural limits of the component formations of that system. Here we have to bear in mind that in the typical area of Shropshire a few feet only of the lowest of the Silurian formations are visible, and even these were not separated by Murchison from the underlying Bala rocks until he was compelled to distinguish them by the discoveries of Sedgwick and M'Coy. And it is now daily becoming more clearly evident that in the same typical area there is, in reality, but a very feeble and degenerate representative of the highest formation of the Silurian rocks of other countries—the wonderfully prolific étages F and G of Bohemia, and the great Helderberg series of North America.

Of the first of the three grand formations into which the Silurian may most naturally be divided, all that is exposed in the typical area of Shropshire are the thin zones of the Henley conglomerate and the *Pentamerus*-Limestone, which lie between the summit of the Bala and the base of the Wenlock shale. In many parts of Wales, however, as is well known, we find three distinct groups of strata in this position, separated from each other by fairly marked unconformabilities. It has generally been the habit to call the first of these subformations by the title of the Lower Llandovery, the second Mayhill or Upper Llandovery, and the third the Tarannon shale. The first is usually believed to be most intimately allied in its palæontological characters to the Bala formation, and the last to be hardly separable from the Wenlock shale. My own researches impel me to the conclusion that these three subformations are far more closely allied to each other than they are to the beds above or below, and that they should be considered as the three consecutive members of a single formation. In the south of Scotland (*Valentia*) these three subformations are recognizable, superposed in conformable sequence, with clear relations to the Bala below and to the Wenlock above, and unitedly covering an area of several thousands of square miles. Until geologists are willing to include the Tarannon in the Llandovery it will therefore be best to speak of this great Scottish formation and its equivalents as the *Valentian* formation, its three divisions, Lower, Middle, and Upper, representing respectively the Lower Llandovery, Upper Llandovery, and Tarannon of Wales and Siluria.

The second natural division of the Silurian system is undoubtedly Murchison's Great Mudstone series, which includes the so-called Wenlock and Lower Ludlow groups, as high as the horizon of the Aymestry Limestone. In Shropshire this great mudstone or *Salopian* formation is by far the most important physical group in the Silurian. Murchison drew the line of demarcation between his Wenlock and Ludlow formations at the Wenlock Limestone. We suspect, however, that this was done less from a palæontological than from an æsthetic point of view, and mainly for the sake of physical symmetry. Murchison admits again and again that his Lower Ludlow is "simply an upward prolongation of the Wenlock shale." The natural boundary is therefore at the summit of this great mudstone group, generally along the line of the Aymestry Limestone, where new physical conditions set in and the rocks contain a comparatively new fauna. Although this improved arrangement destroys the apparent symmetry of the so-called formations of Siluria, I doubt not that its advantages will in time ensure its general adoption. Under this scheme difficulties that have hitherto confronted us in our endeavours to parallel the British and foreign strata of Silurian age would almost wholly disappear; the arrangement of the Welsh strata would lose much of its presently acknowledged artificiality, and approximate much more closely to the order of nature all over the world.

In Shropshire this Salopian or Mudstone formation is overlain by the sandy strata of the Upper Ludlow, the Bone-beds and the Downton Sandstone. For the sake of distinction these may collectively be termed the *Downtonian* formation. Above Llangadock these strata are almost as thick as the Wenlock and Ludlow beds united. As a rule, however, they form but a very insignificant representative of the great limestones F and G of Bohemia and the Helderbergs of North America, the Oesel beds of Esthonia, &c. Their relation to the Dingle beds of Ireland and the fossil-bearing *Lower Old Red* rocks of Scotland it is as yet impossible to determine.

#### *Valentian or Llandovery Formation.*

*Wales.*—No Graptolites have hitherto been quoted from the undisputed Llandovery strata of South Wales; nor was I able personally to detect a fragment in my hasty examination of the typical localities during the summer of last year.

I discovered *Rhabdophora*, however, in abundance in the shales of the so-called Tarannon of the neighbourhood of Conway, North Wales. In the cliffs opposite the picturesque old castle I detected

<i>Climacograptus normalis</i> , Lapw.	<i>Monograptus Becki</i> , Barr.
<i>Diplograptus palmeus</i> , Barr.	— <i>galaensis</i> , Lapw.
<i>Retiolites Geinitzianus</i> , Barr.	— Sedgwicki, Portlock.
<i>Monograptus prionod</i> , Bronn.	— <i>fimbriatus</i> , Nich.
— <i>exiguus</i> , Nich.	— <i>turriculatus</i> , Barr.
— Halli, Barr.	

These are possibly the same beds as the strata near Cerrig-y-druidion, in the basin of the Dee, from which Mr. Marr has recently procured Graptolites, as his list of species includes

<i>Diplograptus palmeus</i> , Barr.	<i>Monograptus Sedgwicki</i> , Portl.
<i>Climacograptus scalaris</i> , His.	— <i>colonus</i> , Barr.
<i>Monograptus lobiferus</i> , M <sup>c</sup> Coy.	

*Lake District*.—In the Lake District the Skellgill or Llandovery rocks (Coniston Mudstones) afford *Rhabdophora* in great abundance. At the typical locality of Skellgill there are two distinct zones of Graptolite-bearing beds. In the lowest (*tenuis*) zone I have detected

<i>Diplograptus folium</i> , His.	<i>Monograptus argutus</i> , Lapw.
— <i>sinuatus</i> , Nich.	— <i>spiralis</i> , Geinitz.
— <i>confertus</i> , Nich.	— Sedgwicki, Portl.
— <i>tamariscus</i> , Nich.	— <i>tenuis</i> , Portl.
<i>Climacograptus normalis</i> , Lapw.	— <i>cyphus</i> , Lapw.
<i>Retiolites perlati</i> , Nich.	— <i>fimbriatus</i> , Nich.
<i>Monograptus gregarius</i> , Lapw.	<i>Rastrites peregrinus</i> , Barr.

The higher (or *argenteus*) zone has afforded me

<i>Diplograptus Hughesi</i> , Nich.	<i>Monograptus Hisingeri</i> , Carr.
— <i>sinuatus</i> , Nich.	— <i>lobiferus</i> , M <sup>c</sup> Coy.
— <i>tamariscus</i> , Nich.	— <i>attenuatus</i> , Hopk.
<i>Climacograptus normalis</i> , Lapw.	— <i>gregarius</i> , Lapw.
<i>Diplograptus folium</i> , His.	— <i>argutus</i> , Lapw.
<i>Rastrites peregrinus</i> , Barr.	— <i>leptotheca</i> , Lapw.
<i>Monograptus argenteus</i> , Nich.	— <i>fimbriatus</i> , Nich.

From beds at Knock near Dufton, higher than the typical *argenteus* zone, *Monograptus exiguus*, Nich., and *Rastrites distans*, Lapw., were collected by Prof. Nicholson and myself in 1874. From a thin black seam in the Pale Shales above we procured a *Monograptus* allied to *M. Halli*, Barr.

In addition to many of the foregoing, Prof. Nicholson \* quotes from the Coniston Mudstones the following forms:—

<i>Diplograptus vesiculosus</i> , Nich.	<i>Diplograptus putillus</i> , Hall.
— <i>pristis</i> , His.	— <i>angustifolius</i> , Hall.

The first named probably occurs in the lowest zone; the rest may be new species.

*Scotland*.—The south of Scotland contains the most prolific Graptolite-bearing beds of Llandovery age yet discovered in Britain. These are the well-known Birkhill shales of the

\* Nicholson, Quart. Journ. Geol. Soc. 1868, p. 523.

Moffat district. They break up very naturally into two main divisions, each with several subordinate zones\*.

In the deepest zones of the Lower Birkhill we meet with

Diplograptus acuminatus, <i>Nich.</i>	Climacograptus innotatus, <i>Nich.</i>
— vesiculosus, <i>Nich.</i>	Monograptus tenuis, <i>Portl.</i>
— modestus, <i>Lapw.</i>	— attenuatus, <i>Hopk.</i>
Climacograptus normalis, <i>Lapw.</i>	

Its highest (*gregarius*) zone is crowded with

Diplograptus modestus, <i>Lapw.</i>	Monograptus argutus, <i>Lapw.</i>
— physophora, <i>Nich.</i>	— cyphus, <i>Lapw.</i>
— folium, <i>His.</i>	— Sandersoni, <i>Lapw.</i>
— tamariscus, <i>Nich.</i>	— concinnus, <i>Lapw.</i>
Climacograptus normalis, <i>Lapw.</i>	— lobiferus, <i>M<sup>c</sup> Coy.</i>
— rectangularis, <i>M<sup>c</sup> Coy.</i>	— triangulatus, <i>Harkn.</i>
Monograptus tenuis, <i>Portl.</i>	— leptotheca, <i>Lapw.</i>
— attenuatus, <i>Hopk.</i>	Rastrites peregrinus, <i>Barr.</i>
— spiralis, <i>Gein.</i>	

The Upper Birkhill beds afford

Diplograptus tamariscus, <i>Nich.</i>	Monograptus tenuis, <i>Portl.</i>
— sinuatus, <i>Nich.</i>	— attenuatus, <i>Hopk.</i>
— Hughesi, <i>Nich.</i>	— spiralis, <i>Geinitz.</i>
— palmeus, <i>Barr.</i>	— lobiferus, <i>M<sup>c</sup> Coy.</i>
Climacograptus normalis, <i>Lapw.</i>	— Clingani, <i>Carr.</i>
— tectus? <i>Barr.</i>	— Sedgwicki, <i>Portl.</i>
Retiolites perlatus, <i>Nich.</i>	— gregarius, <i>Lapw.</i>
Monograptus runcinatus, <i>Lapw.</i>	— Hisingeri, <i>Carr.</i>
— intermedius, <i>Carr.</i>	Rastrites peregrinus, <i>Barr.</i>
— concinnus, <i>Lapw.</i>	— fugax, <i>Barr.</i>
— Halli, <i>Barr.</i>	— distans, <i>Lapw.</i>

The Birkhill beds are succeeded by the vast series of grits, flagstones, and shales which I have denominated the Gala group†. To this group properly belong also the Hawick rocks, which are distinctly inferior to the Riccarton or Wenlock strata of Kirkcudbright and Roxburgh. The Rhabdophora I have collected from the *Gala rocks* of the Eastern districts include

Climacograptus normalis, <i>Lapw.</i>	Monograptus Hisingeri, <i>Carr.</i>
Diplograptus palmeus, <i>Barr.</i>	— Halli, <i>Barr.</i>
Retiolites oboeus, <i>Lapw.</i>	— turriculatus, <i>Barr.</i>
— Geinitzianus, <i>Barr.</i>	— exiguus, <i>Nich.</i>
Rastrites maximus, <i>Carr.</i>	— galaensis, <i>Lapw.</i>
— distans, <i>Lapw.</i>	— Barrandei, <i>Suess.</i>
Monograptus runcinatus, <i>Lapw.</i>	— crispus, <i>Lapw.</i>
— concinnus, <i>Lapw.</i>	— priodon, <i>Bronn.</i>
— Sedgwicki, <i>Portl.</i>	— spiralis, <i>His.</i>
— Becki, <i>Barr.</i>	Cyrtograptus Grayæ, <i>Lapw.</i>
— Salteri, <i>Geinitz.</i>	

\* Lapworth, Quart. Journ. Geol. Soc. 1878, p. 328 &c.

† Lapworth, Geological Magazine, 1870, p. 204.



*Girvan*.—In the Girvan district, the Penkill group, which is the representative of the Valentian or Llandovery of Wales, is composed of the three well-marked consecutive subdivisions of the *Mulloch-Hill beds*, *Saugh-Hill beds*, and *Penkill beds*.

The *Mulloch-Hill beds* consist of a mass of highly fossiliferous sandstones and shales, with a coarse conglomerate at the base. Brachiopods are especially abundant; but Graptolites are excessively rare. The only forms I have collected are

*Climacograptus normalis*, *Lapw.*      *Monograptus tenuis*, *Portl.*  
*Diplograptus acuminatus*, *Nich.*

The *Saugh-Hill beds* consist of flagstones and grits with coarse conglomerates and thick zones of grey shales, locally crowded with well-preserved *Rhabdophora*. *Pentamerus* occurs in millions in the conglomerates and limestones, while the shales of the group on both sides of the Girvan Water are crowded with the following Birkhill Graptolites:—

<i>Diplograptus modestus</i> , <i>Lapw.</i>	<i>Monograptus intermedius</i> , <i>Carr.</i>
— <i>Hughesi</i> , <i>Nich.</i>	— <i>gregarius</i> , <i>Lapw.</i>
— <i>tamariscus</i> , <i>Nich.</i>	— <i>lobiferus</i> , <i>M'Coy.</i>
— <i>folium</i> , <i>His.</i>	— <i>attenuatus</i> , <i>Hopk.</i>
<i>Climacograptus normalis</i> , <i>Lapw.</i>	— <i>leptotheca</i> , <i>Lapw.</i>
<i>Retiolites perlatus</i> , <i>Nich.</i>	— <i>tenuis</i> , <i>Portl.</i>
<i>Rastrites peregrinus</i> , <i>Barr.</i>	— <i>Hisingeri</i> , <i>Carr.</i>
<i>Monograptus Sedgwicki</i> , <i>Portl.</i>	— <i>fimbriatus</i> , <i>Nich.</i>
— <i>cyphus</i> , <i>Lapw.</i>	— <i>Salteri</i> , <i>Geinitz.</i>

The highest division, or *Penkill beds* proper, includes the representatives of the Gala and Tarannon groups. The lowest beds (*the Crossopodia-Shales*) consist of purple and green mudstone with a few Graptolites, principally

<i>Monograptus galaensis</i> , <i>Lapw.</i>	<i>Monograptus runcinatus</i> , <i>Lapw.</i>
— <i>Halli</i> , <i>Barr.</i>	— <i>Sedgwicki</i> , <i>Portl.</i>
— <i>exiguus</i> , <i>Nich.</i>	— <i>spiralis</i> , <i>Geinitz.</i>
— <i>Hisingeri</i> , <i>Carr.</i>	<i>Diplograptus palmeus</i> , <i>Barr.</i>

The highest beds (*Priodon Flags and Grits*) afford

<i>Monograptus galaensis</i> , <i>Lapw.</i>	<i>Monograptus priodon</i> , <i>Bronn.</i>
— <i>Halli</i> , <i>Barr.</i>	— <i>concinus</i> , <i>Lapw.</i>
— <i>Hisingeri</i> , <i>Carr.</i>	<i>Cyrtograptus Grayæ</i> , <i>Lapw.</i>
— <i>Sedgwicki</i> , <i>Portl.</i>	<i>Retiolites Geinitzianus</i> , <i>Barr.</i>

*Ireland*.—The only Irish Graptolite-bearing rocks of Llandovery age as yet carefully studied are the Silurian rocks of County Down. From the *Coal-pit Bay beds* that follow the equivalents of the Hartfell shales on the shores of Belfast Lough Mr. Swanston\* has collected the following Birkhill species:—

\* Swanston, Trans. Belfast Nat.-Hist. Field-Club, Appendix, 1876-77.

<i>Climacograptus normalis</i> , <i>Lapw.</i>	<i>Monograptus Sandersoni</i> , <i>Lapw.</i>
<i>Retiolites perlatus</i> , <i>Nich.</i>	— <i>argutus</i> , <i>Lapw.</i>
<i>Diplograptus vesiculosus</i> , <i>Nich.</i>	— <i>gregarius</i> , <i>Lapw.</i>
— <i>folium</i> , <i>His.</i>	— <i>concinus</i> , <i>Lapw.</i>
— <i>Hughesi</i> , <i>Nich.</i>	— <i>leptotheca</i> , <i>Lapw.</i>
— <i>tamariscus</i> , <i>Nich.</i>	— <i>cyphus</i> , <i>Lapw.</i>
— <i>sinuatus</i> , <i>Nich.</i>	— <i>Hisingeri</i> , <i>Carr.</i>
— <i>modestus</i> , <i>Lapw.</i>	— <i>Sedgwicki</i> , <i>Portl.</i>
<i>Dimorphograptus Swanstoni</i> , <i>Lapw.</i>	— <i>spiralis</i> , <i>Geinitz.</i>
<i>Cephalograptus cometa</i> , <i>Gein.</i>	— <i>fimbriatus</i> , <i>Nich.</i>
<i>Monograptus attenuatus</i> , <i>Hopk.</i>	— <i>triangulatus</i> , <i>Harkn.</i>
— <i>tenuis</i> , <i>Portl.</i>	<i>Rastrites peregrinus</i> , <i>Barr.</i>
	— <i>fugax</i> ?, <i>Barr.</i>

Higher strata, equivalent in all probability to the Gala and Tarannon formations of Britain, occur near Teiveshilly and other localities on Strangford Lough. From these Mr. Swanston\* and the officers of H.M. Geological Survey† have collected

<i>Monograptus Hisingeri</i> , <i>Carr.</i>	<i>Monograptus priodon</i> , <i>Brom.</i>
— <i>McCoyii</i> , <i>Lapw.</i>	— <i>proteus</i> , <i>Barr.</i>
— <i>galaensis</i> , <i>Lapw.</i>	— <i>spiralis</i> , <i>His.</i>
— <i>riccartonensis</i> , <i>Lapw.</i>	— <i>turriculatus</i> , <i>Barr.</i>
— <i>crispus</i> , <i>Lapw.</i>	— <i>Barrandei</i> , <i>Suess.</i>

From the higher (Llandovery) portions of his Pomeroy rocks, Portlock figures in his well-known work‡ the following forms:—

<i>Monograptus Sedgwicki</i> , <i>Portl.</i>	<i>Monograptus turriculatus</i> , <i>Barr.</i>
— <i>tenuis</i> ?, <i>Portl.</i>	<i>Diplograptus folium</i> , <i>His.</i>

together with others it is as yet impossible to identify. I have myself collected from these beds, in addition,

<i>Monograptus gregarius</i> , <i>Lapw.</i>	<i>Monograptus discretus</i> , <i>Nich.</i>
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Mr. Swanston has lately forwarded me from the same beds

<i>Monograptus cyphus</i> , <i>Lapw.</i>	<i>Monograptus leptotheca</i> , <i>Lapw.</i>
— <i>attenuatus</i> , <i>Hopk.</i>	— <i>intermedius</i> , <i>Carr.</i>

Similar forms are present at Lesbellaw§ and other localities in the west of Ireland.

*Sweden.*—The *Trinucleus* (Upper Bala) Schists of Scania and Westrogothia are followed immediately by the Brachio-pod-Schist—strata very prolific in Testacea, but as yet apparently barren of Graptolites. They stand approximately in the place of the British Lower Llandovery and are succeeded

\* Swanston, *loc. cit. supra.*

† Baily, Explanation of Sheets, Geological Survey of Ireland.

‡ Portlock, Geological Report Tyrone, plate xix.

§ Ibid.

by the *Lobiferus* and *Retiolites* beds, which together compose Linnarsson's Upper Graptolite-Schists\*.

The *Lobiferus*-beds are locally very prolific in Rhabdophora. In a collection from these strata, as exposed at Hunneberg, kindly sent me by Dr. Lindström, I recognized

Monograptus lobiferus, <i>M<sup>c</sup>Coy</i> .	Rastrites hybridus, <i>Lapw</i> .
— cyphus, <i>Lapw</i> .	— peregrinus, <i>Barr</i> .
— attenuatus, <i>Hopk</i> .	Diplograptus folium, <i>His</i> .
— triangulatus, <i>Harkn</i> .	— tamariscus, <i>Nich</i> .
Rastrites capillaris?, <i>Carr</i> .	Climacograptus normalis, <i>Lapw</i> .

In a collection from strata of the same age forwarded to Prof. Nicholson† by Mr. Linnarsson, many of the same forms occur, together with

Monograptus Sedgwicki, <i>Portl</i> .	Monograptus Hisingeri, <i>Carr</i> .
— gregarius, <i>Lapw</i> .	Retiolites perlatus, <i>Nich</i> .

From the *Lobiferus*-beds of Kongslena in Westrogothia Mr. Linnarsson‡ has published

Monograptus lobiferus, <i>M<sup>c</sup>Coy</i> .	Diplograptus palmeus, <i>His</i> .
— Hisingeri, <i>Carr</i> .	— modestus, <i>Lapw</i> .
— Sandersoni, <i>Lapw</i> .	— cometa, <i>Geinitz</i> .
— Sedgwicki, <i>Portl</i> .	— tamariscus, <i>Nich</i> .
— spiralis, <i>Geinitz</i> .	Climacograptus rectangularis,
— triangulatus, <i>Harkn</i> .	<i>M<sup>c</sup>Coy</i> .
Rastrites peregrinus, <i>Barr</i> .	

From loose boulders, probably of corresponding age, he has subsequently collected

Monograptus runcinatus, <i>Lapw</i> .	Rastrites maximus, <i>Carr</i> .
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and more recently from grey shales, presently identified with the highest *Lobiferus*-beds of Scania, he has obtained the Gala species§

Monograptus crispus, <i>Lapw</i> .	Monograptus lobiferus ( <i>M<sup>c</sup>Coy</i> ).
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In Dalecarlia the representatives of the Llandovery strata || appear to be the *Kallholn Schists*, *Stygfors Schists*, and *Lep-tena-Limestone* of the neighbourhood of Lake Siljan. From the Kallholn schists Dr. Törnquist enumerated the following species in 1873 :—

Climacograptus teretiusculus, <i>His</i> .	Monograptus sagittarius, <i>His</i> .
Diplograptus pristis, <i>His</i> .	— convolutus, <i>His</i> .
— palmeus, <i>Barr</i> .	Rastrites peregrinus, <i>Barr</i> .
Monograptus Becki, <i>Barr</i> .	

\* Linnarsson, Geological Magazine, June 1876.

† Nicholson, *ibid*.

‡ Linnarsson, Geol. Fören. Förhandl. 1877, p. 404.

§ *Ibid*. 1879, p. 255.

|| Törnquist, Öfvers. af K. Vetensk. Akad. Förhandl. 1874, p. 26.

and from the overlying Stygfors Schists

*Diplograptus folium*, *His.*  
*Monograptus priodon*, *Bronn.*  
 — *proteus*, *Barr.*

*Monograptus convolutus*, *His.*  
 — *turriculatus*, *Barr.*  
*Retiolites Geinitzianus*, *Barr.*

In the collection sent me by Dr. Lindström I also recognized

*Monograptus Halli*, *Barr.*

*Monograptus leptotheca*, *Lapw.*

from the Stygfors Schists.

The *Lobiferus*-Schists occur also in the island of Bornholm, where they afford the same general assemblage of Rhabdophora.

*Thuringia*.—Thanks to the industrious researches of Prof. Geinitz and Dr. B. Richter, the Llandovery strata of Saxony and Thuringia have long been famous for their numerous Graptolitidæ. The true Llandovery age of the containing beds has been generally admitted from the first. As a whole the fauna of the so-called *Kiesel-Schiefer* and *Alaun-Schiefer* of this region is essentially Birkhillian; but, judging from the collective fauna, it is clear that strata of Gala or Taranon age are also present. The group, as a whole, corresponds, both in mineral character and fossils, with Barrande's colonial zone and the lower portion of his zone E e 1.

From the Saxon localities Geinitz figures the following species\* :—

*Diplograptus folium*, *His.*  
 — *palmeus*, *Barr.*  
 — *physophora*?, *Nich.* (i. fig. 21).  
*Cephalograptus cometa*, *Geinitz.*  
*Dimorphograptus Swanstoni*, *Lapw.*  
 (i. 25).  
*Climacograptus rectangularis*,  
*M' Coy.*  
*Diplograptus vesiculosus*, *Nich.* (i.  
 22, 26).  
*Monograptus Hisingeri*, *Carr.*  
 — *tenuis*, *Portl.*  
 — *gregarius*, *Lapw.* (ii. 25).

*Monograptus Halli*, *Barr.*  
 — *lobiferus*, *M' Coy.*  
 — *Sedgwicki*, *Portl.*  
 — *spiralis*, *Geinitz.*  
 — *proteus*?, *Barr.*  
 — *involutus*, *Lapw.* (iv. 9).  
 — *triangulatus*, *Harkn.* (v. 6).  
 — *Nilssoni*?, *Barr.* (ii. 18).  
*Rastrites peregrinus*, *Barr.*  
 — *capillaris*, *Carr.* (iv. 19).  
 — *hybridus*, *Lapw.* (v. 17).  
 — *Linnæi*, *Barr.*

The following Gala-Wenlock forms are also figured by Geinitz, but do not appear to occur in association with the foregoing, being found at Grafenwarth and Linda only :—

*Monograptus priodon*, *Bronn.*  
 — *bohemicus*?, *Barr.*

*Monograptus colonius*, *Barr.*  
*Retiolites Geinitzianus*, *Barr.*

The whole of the forms enumerated by Geinitz have been subsequently noticed by Dr. Richter in his most valuable

\* Geinitz, *Die Graptolithen*, pls. i.-vi.

papers \* on the Graptolites of Thuringia, together with the following species :—

Diplograptus birastrites, <i>Richter</i> .	Monograptus testis, <i>Barr</i> .
Rastrites urceolus, <i>Richter</i> .	—— nuntius, <i>Barr</i> .
Monograptus priodon, <i>Bronn</i> .	—— turriculatus, <i>Barr</i> .
—— gemmatus, <i>Barr</i> .	

all of which, with the exception of the first two, are probably from strata of later age than the Birkhill Shales.

*Bohemia*.—We now enter upon the interesting region of Bohemia, made classic to the student of the Proterozoic rocks by the genius and researches of Barrande. In this area, as already pointed out by Barrande himself, the single division *E e 1* and the hardly separable zone of the colonies are all that represent the British strata interposed between the summit of the Bala and the base of the Upper Ludlow of Murchison. In other words, the Lower and Upper Llandovery, Tarannon, Wenlock, and Lower Ludlow of Siluria find their equivalents in a small group of carbonaceous and calcareous strata not greatly exceeding 300 feet in thickness. At the present time all the fossils from this diminutive group are united under a single head, and the collective fauna shows of necessity a combination of the characteristics of several distinct British subformations. In Bohemia, precisely as in Britain, the earlier stages of the period of the Third Fauna were marked by repeated elevations and depressions of the sea-bed. An additional local complication was introduced through the prevalence of volcanic action during these early stages, as shown in the abundance of igneous rocks, both interstratified and intrusive, with which the fossiliferous strata are associated. The unconformabilities, overlaps, faults, and folds pointed out by Barrande in these strata are, in all probability, accompanied by a host of other physical accidents as yet undetected. When these physical complications shall have been more perfectly unravelled, and the fossils of the beds classified zone by zone, I feel assured that the anomalies which now appear, on a cursory view, to be most naturally accounted for on the hypothesis of successive interchanges of distinct faunas will wholly disappear, and that, as our knowledge of the rocks and fossils of the Proterozoic age increases, the strata of the symmetrical Bohemian basin will be found to admit of minute and satisfactory comparison with those of Britain.

\* Richter, Zeitschrift d. deutsch. geol. Gesellschaft, vols. for 1850, 1851, 1853–1871, &c.

Barrande's first list of his species of the colonies is as follows :—

*Monograptus priodon*, *Bronn.*  
— *bohemicus*, *Barr.*

*Monograptus Roëmeri*, *Barr.\**  
— *colonus*, *Barr.*

a very probable association, but one which (as we shall subsequently show) would in Britain be at once set down as probably existent at the Wenlock period. A fauna distinctly of far older date is given in the extended Catalogue of the Colonial Graptolites printed in the fourth part of the 'Défense des Colonies.' From the Colonie d'Archiac, Barrande † enumerates the following species (exclusive of undescribed forms) :—

*Rastrites peregrinus*, *Barr.*  
*Diplograptus folium*, *His.*  
*Monograptus spinigerus*, *Nich.*  
— *Hisingeri*, *Carr.*  
— *nuntius*, *Barr.*

*Monograptus priodon*, *Bronn.*  
— *Nilssoni*, *Barr.*  
— *Becki*, *Barr.*  
— *colonus*, *Barr.*  
— *bohemicus*, *Barr.*

As a whole this is a group of forms that might be looked for at the very base of the Gala or Tarannon group. There are, however, two forms, *M. colonus*, *Barr.*, and *M. bohemicus*, *Barr.*, which are not met with in Britain or Scandinavia until we reach the Wenlock shale. They are, however, represented in the much earlier Gala rocks by the allied forms *M. galaensis*, *Lapw.*, and *M. concinnus*, *Lapw.*

In the *Colonie Haidinger* the following forms are present :—

*Rastrites peregrinus*, *Barr.*  
*Diplograptus palmeus*, *Barr.*  
*Monograptus Becki*, *Barr.*  
— *bohemicus*, *Barr.*

*Monograptus colonus*, *Barr.*  
— *Nilssoni*, *Barr.*  
— *proteus*, *Barr.*  
— *spiralis*, *Gein.*

an assemblage clearly of the same general geological date as that in the Colonie d'Archiac.

From the *Colonie Krejčí* the only forms enumerated by Barrande are

*Monograptus bohemicus*, *Barr.*  
— *colonus*, *Barr.*

*Monograptus priodon*, *Bronn.*  
— *Roëmeri*, *Barr.*

These are Barrande's original Colonial forms, and, as already hinted, suggest a Wenlock age for this special colony.

The shaly zone *Ee 1*, at the base of the series of strata containing the Third Fauna of Barrande, affords precisely the same general group of Graptolites as the typical Colonies

\* Barrande, *Grapt. de Bohême*, p. 18.

† Barrande, *Défense des Colonies*, iv. p. 126.

themselves. The whole of the forms hitherto published by Barrande from this zone are given in the subjoined list \* :—

Diplograptus folium, <i>His.</i>	Monograptus <i>chimera</i> , Barr.
— palmeus, Barr.	— <i>testis</i> , Barr.
Monograptus priodon, <i>Brom.</i>	— <i>spiralis</i> , Geinitz.
— <i>bohemicus</i> , Barr.	— <i>turriculatus</i> , Barr.
— <i>Ræmeri</i> , Barr.	— <i>proteus</i> , Barr.
— <i>colonus</i> , Barr.	Rastrites Linnæi, Barr.
— <i>nuntius</i> , Barr.	— <i>fugax</i> , Barr.
— Halli, Barr.	— <i>gemmatus</i> , Barr.
— Becki, Barr.	— <i>peregrinus</i> , Barr.
— Nilssoni, Barr.	Retiolites Geinitzianus, Barr.

To judge from this catalogue the band *E e 1* includes representatives of the Upper Birkhill, Gala, and Wenlock beds of Britain and Scandinavia, where the forms in italics are exclusively Wenlock and Ludlow species.

*France*.—The only Graptolitic strata of Llandovery age hitherto detected in France are portions of the *Ampelite-beds* of Anjou and Bretagne, &c. They form two consecutive groups, the *Schiste ampéliteux* and the *Calcaire ampéliteux*, both rightly referred by the French geologists to the Third Fauna of Barrande. These *Ampelite-beds* must include also strata of Wenlock age.

In the *Ampelite-Schists* of Maine et Loire M. Farge has collected†

Monograptus colonus, Barr.	Monograptus spiralis, Gein.
— Becki, Barr.	Diplograptus folium, His.
— Nilssoni, Barr.	

From the higher zone with *nodules ampéliteux*, the representative of the *Ampelite-Limestone* of other districts, Messrs. Tromelin and Lebesconte‡ have obtained

Monograptus bohemicus, Barr.	Monograptus priodon, <i>Brom.</i>
— Becki, Barr.	Retiolites Geinitzianus, Barr.

In their catalogue of the fossils of Anjou and Bretagne these authors enumerate from the *Ampelite-Schists* §

Diplograptus folium, His.	Monograptus Nilssoni, Barr.
Monograptus Becki, Barr.	— spiralis, Gein.
— colonus, Barr.	

*Monograptus testis*, Barr., is quoted from the *Ampelite-Schists* of the department of the Sarthe. If properly identified, I suspect this is from higher beds, of true Wenlock age.

\* Barrande, Grapt. de Bohême, p. 18.

† Tromelin and Lebesconte, Catalogue Silurian Foss. 1875, p. 52.

‡ Ibidem ibid.

§ Ibid. Table A.

*Spain.*—Rocks of Llandovery age occur also in the southern districts of the Peninsula. Among the so-called Lower Silurian fossils enumerated by De Verneuil and Barrande as present in the Lower Palæozoic strata of Almaden and the Sierra Morena are found \*

*Monograptus spiralis*, Geinitz.  
— Halli, Barr.

*Monograptus priodon*, Bronn.  
*Diplograptus palmeus*, Barr.

*America.*—Throughout the United States and Canada the Llandovery strata consist almost wholly of coarse sandy non-fossiliferous beds or of calcareous rocks abounding in Brachiopoda, but destitute of Graptolites. The Clinton beds, which may be roughly paralleled with our Tarannon Shales, afford the peculiar American forms

*Monograptus clintonensis*, Hall.

*Retiolites venosus*, Hall.

*Salopian (or Wenlock and Lower Ludlow) Formation.*

The great Mudstone or Salopian formation of Shropshire is more or less graptolitiferous throughout. In a few localities its basal strata afford *Rhabdophora* in remarkable abundance. As we ascend the succession they gradually diminish in numbers, as a general rule. To this, however, there are exceptions. One of the most noticeable is that at the base of the Lower Ludlow, where, more especially in Hereford and Radnor, some of the beds are crowded with Graptolites. They are, however, of but few species, and belong to a single genus only. About the horizon of the Aymestry Limestone they vanish altogether; but whether this is due to the change in the composition of the strata, which here begins to take on a coarse sandy character, or whether it is owing to rapid extinction of the order, it is as yet impossible to determine.

(a) *Zone of Cyrtograptus Murchisoni*, Carr.

*Wales.*—The base of the Wenlock or Salopian series of the neighbourhood of Builth is formed of a few feet of calcareo-carbonaceous shales, crowded with fairly preserved *Rhabdophora*, among which the beautiful species *Cyrtograptus Murchisoni*, Carr., is especially conspicuous. It is associated with

*Monograptus priodon*, Bronn.  
— Halli, Barr.  
— vomerinus, Nich.

*Monograptus colonus*, Barr.  
*Retiolites Geinitzianus*, Barr.

The same zone is probably present in the shales at the base of the Wenlock, on the banks of the Onny, near Plowden,

\* De Verneuil et Barr. Bull. Géol. Soc. France, 1855, p. 964.



&c., where I have procured fragments of *Cyrtograptus Murchisoni*.

*Lake District*.—Throughout the Westmoreland region the zone of *C. Murchisoni* seems to overlies the *Pale Slates* proper, and to form the base of the Coniston series. From the lowest beds of the Coniston Flags near Broughton have been collected, either by Prof. Nicholson or myself\*,

<i>Cyrtograptus Murchisoni</i> , Carr.	<i>Monograptus rickartensis</i> ?,
<i>Monograptus priodon</i> , Bronn.	<i>Lapw.</i>
— Halli, Barr.	— colonus, Barr.
— vomerinus, Nich.	<i>Retiolites Geinitzianus</i> , Barr.

*Sweden*.—The same zone has been detected by Mr. G. Linnarsson at the base of the *Retiolites*-beds of Scania. From this zone at Röstänga Herr v. Schmalensee has collected †

<i>Cyrtograptus Murchisoni</i> , Carr.	<i>Monograptus vomerinus</i> , Nich.
<i>Monograptus priodon</i> , Bronn.	<i>Retiolites Geinitzianus</i> , Barr.

The same zone is recognizable in many other localities, always affording its characteristic fossils.

*Bohemia*.—Mr. Carruthers ‡ recognized *Cyrtograptus Murchisoni* in a collection of Graptolites forwarded by Barrande to the British Museum, London. Its true horizon in Bohemia is unknown.

### (b) Higher Wenlock Strata.

*Wales*.—In the main mass of the Wenlock Shales, Graptolites are rarer than in the *Murchisoni* zone. Locally, however, they are abundant. From the Wenlock Shales, near Builth-Road Station, Radnorshire, I have collected

<i>Cyrtograptus Linnarssoni</i> , Lapw.	<i>Monograptus Halli</i> , Barr.
<i>Monograptus colonus</i> , Barr.	— vomerinus, Nich.

The same forms occur in the Wenlock Shales of the valley of the Onny, above Horderly, the first named in fragments only.

*Lake District*.—In the higher Coniston Flags of the Lake District I have myself collected

<i>Retiolites Geinitzianus</i> , Barr.	<i>Monograptus vomerinus</i> , Nich.
<i>Monograptus priodon</i> , Bronn.	— colonus, Barr.

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\* Professor Hughes enumerates also *Monograptus Flemingii*, Salt., and *Monograptus latus*, McCoy, from these beds (Mem. Geol. Survey England and Wales, Explan. Sheet 98, S.E., p. 11).

† Linnarsson, Obs. Grapt. Schists of Scania (Geol. Fören. Förhandl. 1879, p. 256).

‡ Carruthers, Geol. Magazine, vol. v. p. 128.

and in Prof. Nicholson's fine collection I recognized, as being also procured from these beds,

Monograptus Halli, Barr.  
— bohemicus, Barr.

Monograptus dubius, Suess.  
— riccartonensis, Lapw.

*Scotland*.—From the *Riccarton Beds* of the basin of the Solway, which stand generally in the place of the Wenlock of Siluria, the following forms have been collected by Mr. James Wilson or myself\*:—

Retiolites Geinitzianus, Barr.  
Cyrtograptus Carruthersi, Lapw.  
Monograptus priodon, Bronn.  
— riccartonensis, Lapw.

Monograptus vomerinus, Nich.  
— colonus, Barr.  
— dubius?, Suess.

Near Straiton, in the county of Ayrshire, beds probably belonging to the base of the Riccarton series afford

Monograptus vomerinus, Nich.      Cyrtograptus, sp.

From the Wenlock strata of Habbies Howe, in the Pentland Hills, Mr. Henderson † has collected

Retiolites Geinitzianus, Barr.  
— colonus, Barr.

Monograptus priodon, Bronn.  
— vomerinus, Nich.

*Sweden*.—According to the most recent communications of Mr. G. Linnarsson, the *Retiolites Skiffer* of Scania, which succeed the zone of *Cyrtograptus Murchisoni*, already referred to, fall into two main divisions ‡, viz.:—

(1) Strata with *Monograptus testis*, Barr.

(2) Strata with *Monograptus colonus*, Barr.

Near Jerrestad and Tomarp the dark grey schists with calcareous nodules that compose the "Strata with *Monograptus testis*" yield

Monograptus testis, Barr.  
— priodon, Bronn.

Monograptus colonus, Barr.  
Cyrtograptus, sp.

The overlying "Strata with *M. colonus*" are comparatively barren greenish and grey schists, and have a wide geographical extension in Scania. They afford principally

Monograptus colonus, Barr.  
— priodon?, Bronn.

Monograptus Barrandei, Suess.

and they are especially characterized by the presence of *Cardiola interrupta* (Brod.), which is unknown in the underlying Scanian formations.

*Norway*.—To this general Wenlock horizon probably

\* Lapworth, Scottish Monograptidæ, Geol. Mag. 1876.

† Lapworth, Trans. Edinburgh Geol. Soc. 1874.

‡ Linnarsson, Observations on Graptoliferous Schists of Scania (Geol. Fören. Förhandl. 1879, p. 256).

belong the Graptolitidæ figured by Prof. Kjerulf from his étage 8 of the Proterozoic rocks of Christiania\*. They include

*Monograptus priodon*, *Bronn*.  
— *colonus*?, *Barr*.

*Retiolites Geinitzianus*, *Barr*.  
*Cyrtograptus*, sp.

*Bohemia*.—The forms enumerated by Barrande from the Limestone beds of the étage E have a decidedly Salopian facies†. They are

*Monograptus priodon*, *Bronn*.  
— *bohemicus*, *Barr*.  
— *Rœmeri*, *Barr*.

*Monograptus colonus*, *Barr*.  
— *chimæra*, *Barr*.

*France*.—Among the fossils collected by M. de Grasset at Cabrières, near Neffiez (Hérault), in Languedoc‡, the following Salopian group of *Rhabdophora* is noticed:—

*Monograptus bohemicus*, *Barr*.  
— *priodon*, *Bronn*.

*Monograptus Rœmeri*, *Barr*.

These are found, as usual, in association with *Cardiola interrupta* (Broderip).

#### (c) Lower Ludlow Beds.

*Wales*.—The distribution of the *Rhabdophora* in the Lower Ludlow rocks of Siluria was made the subject of special study by Mr. Hopkinson in 1873; and a brief summary of his conclusions was communicated to the British Association in that year. The results of my own hasty examination of these rocks during the summer of 1879 were in the direction of confirming his general conclusions, without adding any new facts of special importance.

According to Mr. Hopkinson the Lower Ludlow rocks of Leintwardine and its neighbourhood afford §

*Monograptus colonus*, *Barr*.  
— *leintwardinensis*, *Hopk. MS.*

*Monograptus Salweyi*, *Hopk. MS.*  
— *Rœmeri*, *Barr. &c.*

Of these, *Monograptus leintwardinensis* is most emphatically the characteristic fossil of the zone. I met with it in extraordinary abundance not only near Leintwardine, but also near Barrington, Adferton, and Vinnal, &c., near Ludlow. I met with it also in swarms, but indifferently preserved, in the Lower Ludlow of the neighbourhood of Presteign and New Radnor.

\* Kjerulf, Veiviser, 1865, p. 31.

† Barrande, Graptolites de Bohême, p. 18.

‡ Tromelin et Lebesconte, Catalogue Foss. siluriens, 1875, p. 54.

§ Hopkinson, Geological Magazine, 1873, p. 520; *ibid.* 1875, p. 561.

*Downtonian Strata.*

Above the horizon of the Aymestry Limestone, which forms the divisional line between the Lower and Upper Ludlow groups of Murchison, no distinct species of Graptolite has yet been identified. Prof. Phillips\* notices the presence of Graptolites in the Upper Ludlow of the Malvern Hills, but does not attempt their identification. Mr. R. Etheridge† catalogues a fragment of a Graptolite from the supposed Lower Old Red Sandstone of Lanarkshire. Mr. G. Linnarsson informs me that he has recently recognized a Graptolite in a collection of fossils from the Gothland Sandstone, which possibly corresponds to the lower part of the British Downtonian series.

[To be continued.]

VI.—*On the Action of Light and the Function of Chlorophyll in Plants.* By M. PRINGSHEIM‡.

MY purpose in this preliminary communication is to state some results which I have obtained by a new and peculiar method of investigation in *concentrated sunlight*.

I have made use of this method for some years in order to gather experimental knowledge of the relations of light to the absorption of gases by growing plants, and of the part played therein by chlorophyll. Amid the confusion of contradictory opinions and statements which pervade the literature of the subject, after many vain endeavours to advance upon the path usually trodden, I felt myself bidden to proceed to the employment of *intensified light*. I hoped thus to be able in a short time to bring into view, and unequivocally to observe immediately in the cell, and directly under the microscope, the processes called forth in plants by the action of light.

In fact the experiments which have hitherto been made have laboured under the serious defect that too inconsiderable intensities of light were employed. This is especially true of those experiments in which it was endeavoured to prove that the different colours of the spectrum act differently upon plants. If plants are grown in diffused daylight, or even in direct sunshine behind coloured screens or coloured glasses or

\* Phillips, Mem. Geolog. Survey, vol. ii.

† Etheridge, Mem. Geol. Survey Scotland, Explan. Sheet 23, p. 57.

‡ Translated from the 'Monatsbericht der königlich preussischen Akademie der Wissenschaften zu Berlin,' July 1879, pp. 532-546.

liquids, they evidently grow in relative obscurity in comparison with their normal conditions, even in relation to the colour the action of which is wished to be investigated ; hence the results thus obtained correspond only to the actions produced in plants by *insufficient* intensities of light. Moreover the function of chlorophyll itself contributes to the weakening of the result. I mention this because certain conjectures respecting the function of chlorophyll, which have since been verified, first induced me to take up these experiments with higher intensities of light.

So long as I employed only comparatively inconsiderable augmentations of the intensity, I obtained no decisive results. I at last attained satisfactory effects when I ventured to bring organic forms, vegetable and animal cells and tissues, into the plane of an image of the sun which I projected in the focus of an achromatic lens of 60 millims. diameter.

The apprehension which perhaps at first arises, that organic structures must under these circumstances be forthwith destroyed by the thermal action of the solar image, is, as a closer consideration and direct experiment show, unfounded. With proper precautions, the object can be observed undisturbed for a considerable time in the sun's image, as indeed is approximately shown by the phenomena in the so-called solar microscope. In this way the influence of the radiation upon an entire tissue and upon *each single cell*, nay, even upon *the different form-constituents of a single cell*, can be *separately* studied, and with a little attention the thermal and photochemical effects of the radiation can be certainly and sharply distinguished.

Hence this method of *microscopical photochemistry* (as I would call it) is preeminently adapted for investigating whether any, and what, photochemical actions of light take place in protoplasm and in the formed constituents of the cell-body ; and it is equally suitable for determining the relative degree of diathermasy of the cell-contents and the cell-membrane. In this way also the effects of higher degrees of heat can be more conveniently brought into view than by aid of heated object-tables. Lastly, it is self-evident that the method is applicable for animals and animal tissues as well as for plants ; and with it we can at the same time demonstrate the sensation of heat in the lowest classes of animals (Protozoa and Cœlenterata), and in certain cases ascertain the truth respecting the presence, and the seat, of the perception of light.

The experiments in reference to this which, in the course of my investigations, I have made on animals I will communicate subsequently ; I will here preliminarily enter more

minutely only into that part of my researches which has for its subject the influence of light upon the plant-cell.

If a chlorophyll-bearing tissue, or even a single cell containing chlorophyll (a moss-leaf, a fern-prothallium, a *Chara*, a *Conferva*, or a section of a leaf of any Phanerogamic water- or land-plant &c.), be placed in the usual manner under the microscope, while, at the same time, by means of a heliostat and a lens of about 60 millims. diameter, the image of the sun is thrown upon the plane of the field of vision at the spot in which the object is, so that the latter appears formally immersed in the image, in a few minutes (from 3 to 6 and upwards) very considerable and energetic changes can be seen to take place in the object.

The first phenomenon seen, more striking than any other, is the *complete destruction* of the chlorophyll under the eye of the observer. The green plant-cell, exposed only a few minutes to the concentrated sunlight, makes exactly the same impression as if it had lain for twenty-four hours in strong alcohol. The green colouring-matter has disappeared, while the primitive substance of the chlorophyll has for the most part its forms entirely preserved, and even its nature apparently not essentially altered. But in the experiments in the light it will be possible to localize the decolorization, and at pleasure to confine it to a single cell or even a portion of a cell; for the destruction strikes only the place upon which the light is directly incident; so that, for instance, in a cell a single chlorophyll-grain, a single turn of a filament in a *Spirogyra*, &c. are decolorized, while the adjacent grains of chlorophyll and the next preceding and following coils remain intact in form and colour.

The changes which take place, however, are not limited to the destruction of the green colouring-matter only; they *gradually attack also the other constituents of the cell*, and, according to the duration of the action of the light, go on to the complete death of the entire cell. Thus, if its duration is protracted, the motion of the granules in threads of protoplasm, and the circulation of the protoplasm itself, where they previously existed (as in the utricles of *Nitellæ* and *Charæ*, in the leaf-cells of *Vallisneria*, in the hairs of the staminal filaments of *Tradescantia*, in the stinging hairs of *Urtica*, &c.), are arrested; the threads of protoplasm break; the normal arrangement of the cell-contents is destroyed; the cytoblast, where it occupies certain positions (as in the *Spirogyræ*), is dislocated, breaks away from the threads of protoplasm to which it is suspended; the cuticular layer contracts, loses its impermeability to colouring-matters; the

turgescence of the cell is annihilated; in short, the cell exhibits all the phenomena of rapid and irreparable destruction.

These phenomena are *not* direct effects of a high temperature produced in the cell by the radiation. By varying the experiment by means of coloured screens, causing the rays which delineate the image of the sun to pass through coloured glasses or vessels containing coloured fluids, this can be rendered highly probable, as I will show in my detailed presentation of the subject. I will here merely mention that the destruction of the contents of the cell in the way above portrayed takes effect in *all colours*. It matters not whether the image of the sun is produced as a *warm red* image behind a solution of iodine in sulphide of carbon, or as a *green* one behind a solution of chloride of copper, or as a *cold blue* one behind ammonio-cupric sulphate; the result is always the same, provided only that the coloured screens transmit a light of *sufficient* intensity.

It is, however, easily perceptible, even without photometric measurement, that *blue* light exerts a more powerful action than *red*. Behind a solution of iodine in sulphide of carbon so concentrated that, except the red up to the wave-length 0.00061 millim., to the human eye it transmits no portion of the spectrum, especially no blue, even in direct sunlight, the phenomena described will *not* be seen to occur even with long-continued action of the sun's image, although here at least 80 per cent. of the total heat of the white image is effective, and although this red image still possesses a brightness unendurable even for a very short time by any human eye, and, finally, although the first two strong absorption-bands of the chlorophyll-spectrum fall in the red of this image of the sun, and consequently this red is absorbed in considerable quantity by the chlorophyll.

On the other hand, a rapid and powerful action always takes place behind even a *dark* solution of ammonio-cupric sulphate, which absorbs the entire less-refrangible half of the solar spectrum to about the wave-length 0.00051 millim., and likewise behind a screen of deep-green glass, which is but very slightly diathermanous.

But, apart from the action being independent of the greater or less diathermasy of the screen, the most direct proof can be adduced that the destruction wrought in the cell does not depend upon the thermal action of the radiation; for it can be shown that the occurrence of all the phenomena of destruction of the cell and its contents in the light is exclusively conditioned by the presence of oxygen in the surrounding atmosphere.

*The destruction does not take place in media free from oxygen.*

If the experiments be made in a so-called microscopic gas-chamber, through which various gases can be passed during the experiment, the effects above described take place only in atmospheric air and in media containing oxygen; but they constantly fail to appear, under otherwise like conditions, even if the experiment be continued twice or three times as long, in hydrogen or media containing no oxygen. But both when atmospheric air passes through the gas-chamber, and when oxygen is substituted for the air, the absorptions of the chlorophyll remain unaltered, and the thermal actions of the sun's image at least equal. If, however, the experiment be *excessively prolonged* in hydrogen, disturbances, it is true, will be seen to occur; but these, even in their first stages, are essentially different from those described, and are easily shown to be thermal effects.

Even in a *mixture of pure hydrogen and carbonic acid* cleared as much as possible of free oxygen, under these circumstances neither in any colour nor in white itself does any photochemical action appear: the green cell remains therein perfectly green and in every respect undangered.

On the other hand, the *abstraction of the carbonic acid* has not the slightest influence upon the occurrence of the action. In air containing oxygen, from which by all possible means the carbonic acid is abstracted before it enters the gas-chamber, the decolorizing of chlorophyll, the destruction and death of the cell take place as rapidly as in media containing carbonic acid.

The conclusions to be drawn from these experiments are clear and simple.

If we in the first place stop at the action of the light upon the green colouring-matter, we find in the demonstrable dependence of the phenomenon upon the presence of oxygen, and in its independence of the abstraction of carbonic acid, proof that *the destruction of chlorophyll by light in the living plant is an act of combustion influenced and promoted by the light, and stands in no relation to the decomposition of carbonic acid by the plant.*

By varying the experiment, *e. g.* shortening its duration by stopping the action before *complete destruction* of the colouring-matter in the chlorophyll-bodies, it can further be shown that the cell and, in like manner, the individual chlorophyll-grain are incapable of restoring the destroyed colouring-matter of the partly decolorized chlorophyll-bodies, although with so brief a duration of the action of the light the cell behaves in all



other respects quite normally, remains living, and may even continue to grow.

This incapacity of the cell, and of every single chlorophyll-grain, to regenerate the colouring-matter destroyed by light holds good for all, even *the least, degrees* of weakening or destruction of colour in the chlorophyll-grain. It hence follows that the destruction of chlorophyll by light *cannot be a normal, physiological act* in the life of the plant, but is a detrimental and pathological process.

What becomes of the chlorophyll colouring-matter on its destruction by light in the cell I could not make out, although I took much pains for the purpose of doing so. I did not succeed in a microchemical way in discovering any substance, in the cell decolorized by light, which could be regarded as the product of the destruction of the chlorophyll. A possible simultaneous augmentation of the oil or the starch of the decolorized cell, or the formation of grape-sugar or dextrine, cannot be ascertained. Hence I am inclined, so far as my investigations have yet extended, to assume that herein the chlorophyll passes direct into the gaseous products of the respiration of the plant.

With respect to the rest of the above-sketched destruction-phenomena, which occur with these experiments in intensified light *in the protoplasm and the not green contents of the cell*, and which can be heightened to the death of the cell, there is no doubt that they too are *direct* photochemical actions of light. They are *not* immediate thermal effects of the sun's image; nor are they *secondary* phenomena produced, as might perhaps be thought, by some yet unknown poisonous products of the destruction of the chlorophyll colouring-matter in light. This is proved, first, by experiment on cells which are colourless and contain no chlorophyll—as, for example, on the hairs of the filaments of *Tradescantia*, on the stinging-hairs of *Urtica*, &c., in which the arrest of the motion in the threads of protoplasm and their destruction in light occur in a similar manner and under the same circumstances as in green cells and is promoted by the presence of oxygen.

A sufficiently rigorous demonstration can moreover be obtained with *green* cells and tissues, if, in the way above mentioned, we shorten the duration of the experiment, breaking it off *after* the destruction of the chlorophyll and *before* the cell-contents beneath this have suffered under the action of the light. Singularly favourable for experiments of this kind are the long utricles of *Nitella*. If a small fraction of the length of one of these be exposed to the influence of light, and the experiment be stopped when the chlorophyll is de-

prived of colour but the motion of the protoplasm in the utricle is still maintained, this will continue living for days and weeks and behave quite like a normal, uninjured utricle.

Frequently the decolorized chlorophyll-bodies, if the experiment has been stopped at the right time, then fall down from the wall of the utricle into the level of the current, are carried along and circulate with it uninterruptedly, and without being altered, in the regular path of its flow, and travel the whole extent of the path through the entire utricle with the same velocity as the other large formed bodies contained in it (the mucilaginous and ciliated corpuscles), without further disturbing the course of the current.

The place on which the light has fallen, however, appears completely bare, and, denuded of chlorophyll-bodies, lets the underlying cell-contents be directly seen. At the same time the wall-coating of the green parts of the utricle may remain quite unaltered and exhibit, for instance, the chlorophyll-bodies, the arrangement of the chlorophyll series, the indifference-streaks, &c. in normal condition quite as usual. These utricles with a spot denuded of chlorophyll-bodies by light present a singular appearance.

If this utricle be placed with the same spot (now denuded of chlorophyll) again exposed to intense light, in it also there follows the destruction of the contents of the cell, without any further decolorization of the chlorophyll bodies, just as before in the green utricles which were submitted to a longer action of the light, and, in fact, more quickly than in these.

This experiment therefore proves that the destruction of the contents of the green cells is independent of the chlorophyll colouring-matter, and shows (since the destruction occurs or does not occur in the gas-chamber under the same circumstances here also as in the green cells) that the destruction of protoplasm by light is also an act of combustion evoked by the heightened respiration in the light—or, in other words, that with the intensity of the light the affinity of oxygen for the combustible elements in the interior of the cell is increased. *But this experiment also shows that the chlorophyll, as long as it lasts, acts as a protective covering, moderating the injurious influence of light upon the protoplasm.*

Hence these experiments, by which is demonstrated the destructively heightened respiration of plants in intense light, at the same time bring to light the hitherto unimagined function of chlorophyll—by its strong absorption of the so-called chemical rays especially, *to limit the intensity of, and thus to regulate, the respiration.*

Now I have further taken the trouble to investigate which

constituents of the plant-cell, being consumed in oxygen, are used up as the proper combustibles in the respiration of the cell. This question, too, had not yet been attacked. Investigation in intense light gives us the means of approaching it more closely.

Convincing evidence is easily obtained that all the better-known formal constituents of the cell-body, even in intense light, are incombustible and indestructible inside the cell. This holds true of the cell-wall, of the starch-grains, also of the amylaceous contents of the chlorophyll-bodies, and of the fatty matters (*i.e.* both those enclosed in the chlorophyll-bodies and the fat-globules occurring independently in the cell). Therefore none of these substances in the plant is directly utilized for the respiration. The cytoblast likewise, in the plant in intense light, appears incombustible; the changes which it undergoes I am inclined to regard as secondary effects of the alterations otherwise originated in the plasma in the light. On the other hand, in the protoplasm itself it is incontrovertible that alterations take place which prove themselves to be direct attacks of the oxygen-respiration taking place in light. It is especially remarkable that the *granules* within the contractile threads of protoplasm grow less and disappear. It can with equal distinctness be demonstrated that that envelope of the cell-body which I have named the cuticular layer\* (Mohl's "primordial utricle") is diminished in mass, and that the granules (turned brown by iodine) which are so frequently imbedded in the cuticular layer become perceptibly fewer in number, so that, as it appears, hereby the most essential properties of the cuticular layer are changed.

Hence these bodies (of the chemical constitution of which we possess no further knowledge) preeminently represent the combustible material in the cell, which is expended in respiration. Respecting their nature perhaps an explanation may be given by the discovery (which I succeeded in making) of a previously unknown body in the plant-cell, which, of all the constituents it contains, may be designated as the most sensitive and the most perishable under the influence of light.

I ascertained, namely, that in the elementary substance of the chlorophyll-bodies, likewise in the elementary substance of the so-called amorphous chlorophyll in those plants which as yet possess no formed chlorophyll-bodies, and in every chlorophyll-green plant-cell without exception, there is present and distinguishable a peculiar body, on the preparation of

\* 'Untersuchungen über den Bau und die Bildung der Pflanzenzelle.' Berlin, 1854.

which on a large scale, and the determination of its chemical properties, I am still engaged.

This body, which I call *hypochlorin* or *hypochromyl* (because it stands in the closest relation to the chlorophyll and constantly as it were occurs under it), can be with extreme facility brought into view by microchemistry. In order to see it emerge, we have only to place any chlorophyll-green tissue (no matter from what section of phanerogams or cryptogams) for from twelve to twenty-four hours in diluted hydrochloric acid. The hypochlorin then makes its appearance in the form of extremely minute viscous drops which grow larger by accumulation, or masses of a semifluid consistence, which gradually become indistinctly crystalline scales or tufts, and finally grow out into indistinctly crystalline needles.

This body proves, from all its microchemical characters, to be an unctuous substance bathing the elementary substance of the chlorophyll-bodies, soluble in alcohol, ether, oil of turpentine, and benzole, insoluble in water and salt-solutions, and, after separation from the elementary substance, hardening in a shorter or longer space of time, perhaps through oxidation, into an obscurely crystalline body possessing all the properties of a resin or species of wax (in the sense of the older pharmacological chemistry). In their indistinctly developed forms, the needles formed by this substance remind one, in some measure, of the various shapes of bacilli of the bloom on the surface of the leaves in the Musaceæ and Gramineæ—for example, in *Heliconia farinosa* and the sugar-cane. From all these properties I have come to the opinion (with the reservation of a more exact chemical analysis which I contemplate making of it) that this body represents an ethereal oil which becomes resinous, if already in the ground-mass itself it does not form a mixture of several bodies of that kind (after the manner of the so-called balsams). But, apart from its more intimate chemical constitution, so much is certain, that this body, with its striking and easily demonstrable properties, is a constant and never-failing companion of the green colouring-matter in the ground-mass of the chlorophyll-bodies.

*It is in fact never absent from any chlorophyll-green plant.* It is more generally distributed in the chlorophyll-bodies than their starch and oily matters, and appears with them both in chlorophyll-bodies containing starch and in those which carry fat, and also in those containing both fat and starch. It is only those plants which possess no *proper green* chlorophyll (Phycobromaceæ, Diatomeæ, Fucaceæ, and Florideæ) that appear to exhibit a different behaviour; on this, however, my investigations are not yet concluded.

The universality of the occurrence of this body in all green chlorophyll-bearing plant-cells, its generation in light, its relation to oxygen, and its behaviour to the amylaceous contents of chlorophyll-bodies scarcely permit us to doubt that it is a true *primary* assimilation-product of green plants, from which, under the influence of light, are brought forth by oxidation the starch and oil enclosures of the chlorophyll-bodies as the reserve-substances destined to supply the elements for the circulation.

Hypochlorin, further, proves itself to be the most readily combustible, in light and oxygen, of all the constituents of the cell. It is consumed even sooner than chlorophyll by intense light in the presence of oxygen. For the ordinary intensities of light, under which the plant vegetates, chlorophyll affords sufficient protection to hypochlorin. With the heightened intensities in the experiments, that shelter no longer suffices, and even the light transmitted by the chlorophyll is intense enough for its rapid destruction in oxygen.

That hypochlorin, present in the normal conditions of the plant in variable amount in every grain of chlorophyll, is subjected to an uninterrupted increase and decrease can easily be shown; and all comparative investigations between younger and older states of development of the chlorophyll-grains decidedly indicate that the accumulation and growth of starch in the ground-mass of chlorophyll-bodies advances hand in hand with a diminution of the hypochlorin in them. In darkness the hypochlorin (which, as it appears at least from my experiments hitherto, does not directly participate in the circulation of substance) is more stable than the starch—which again only shows that its transformation into more highly oxidized substances in the cell is accelerated by the heightened respiration in the light.

The facts here briefly sketched disclose a series of new points of view for judging of the action of light on plants. The demonstrable conditions under which the destruction of chlorophyll in the living plant is effected, the knowledge of the eminent augmentation of the amount of respiration with the increase of light-intensity (which may in every colour grow to such a degree as to destroy the cell), the undeniable influence exerted by the light-absorptions in the chlorophyll upon the amount of the respiration, finally the discovery of hypochlorin with its properties, conditions of origin, and behaviour in light, permit, if I am not mistaken, a more correct estimate of the hitherto misunderstood oldest and most

general experiences on the relations between the gas-exchange of plants, light, and the function of chlorophyll.

I reserve the critical estimation of the bearing of the results here communicated of my observations upon the older statements and notions for the full description which is to appear in one of the next numbers of my '*Jahrbücher für wissenschaftliche Botanik*,' where the necessary figures for illustration will be given. But I will here briefly epitomize the most important points of view for a preliminary elucidation.

I. As regards chlorophyll, the possibility of its destruction by light, in the living plant, is unequivocally demonstrated; but at the same time it is shown that the destruction is not a normal, but a pathological process. The plant cannot regenerate the destroyed colouring-matter; and the destruction itself is independent of the absorption of  $\text{CO}_2$ ; hence it cannot play any part in the assimilation of carbon.

This overthrows every chemical theory that would indicate a genetic origin of the hydrates of carbon from chlorophyll.

It is further made evident that the destruction takes place in rays of all colours—in the red, yellow, green, and blue; and it is shown that no definite relation exists between the maxima of light-absorption in the chlorophyll colouring-matter and the colour which originates the destruction.

II. As regards *respiration*, not only is the proof produced (which, in full rigour, has hitherto been wanting) that the absorption of oxygen takes place also in direct sunlight—a proposition which strictly was previously only a theoretical postulate,—but it is at the same time shown that respiration is uncommonly heightened when the intensity of the light is increased. It is therefore a simple consequence, as also the directly proved result of my experiments, that the chlorophyll colouring-matter, by its strong absorption of light, lowers the amount of respiration, as it suspends the operation of the photochemically most operative portion of the radiation. Further the materials are discriminated which are used up in the respiration of the plant-cell; and a series of well-known form-constituents of it are shown to have no part in this.

III. For the deeper insight into the process of *assimilation*, by the proof of the presence in all chlorophyll-bodies of a previously unknown body, from which proceeds the starch enclosed in them, the universal primary product of assimilation of green plants is discovered. It is already, from the microchemical and morphological properties of this body, rendered in the highest degree probable that it is either a pure hydrocarbon, or else belongs to the series of organic plant-

constituents which contain less oxygen than the so-called hydrates of carbon.

This, again, if the most probable hypothesis be admitted, that plants build up their first carbonaceous material out of carbonic acid and water, explains in a natural way why, notwithstanding the exceedingly heightened respiration in light, the volumes of the air-filled closed spaces in which plants are cultivated in sunlight may yet remain unaltered in magnitude.

IV. The *function of the green colour of vegetables* is reduced, in a way widely deviating from present notions, to its importance for the respiration of oxygen. It is shown that chlorophyll, as the regulator of the plant's respiration in light, by its strong absorption of the chemically most operative rays, depresses the amount of the respiration of green plants below that of their assimilation, and thus renders possible the accumulation of carbon-containing products and the existence of the plant in light.

This extinction of the blue rays in chlorophyll at the same time accounts for the observed greater efficiency of the rays of medium refrangibility for the evolution of the oxygen of the plant, as well as for the apparent coincidence of the assimilation-curve of the plant with the brightness-curve of the human eye. Unquestionably the maximum of assimilation for different plants lies in different parts of the effective rays of medium refrangibility, and depends on the amount of extinction (absolutely different for different plants) of the chemical rays in the chlorophyll.

Is this function of limiting the respiration the only one which chlorophyll exercises in the gas-exchange of plants? I shall return to this question in subsequent papers. It is indubitable that at present it is the only one actually demonstrated; for the sole support which, since the discovery of the giving-out of oxygen by plants, has hitherto always again and again been urged for the direct participation of chlorophyll in the process of decomposing carbonic acid, namely that only green parts liberate oxygen, finds in the lowering of the amount of the respiration by the chlorophyll its sufficient explanation.

V. In conclusion, it must be mentioned that for a series of plant-constituents belonging to the class of ethereal oils and their immediate derivatives, and which it has been customary to explain as exclusively products of a retrograde metamorphosis, a universal immediate origin within the elementary substance of every chlorophyll-grain is demonstrated—a further following-out of which promises important elucidation.

tions respecting the distribution and occurrence of those bodies.

There is scarcely any phenomenon in the plant-world under the influence of light for the judging of which some new or essentially changed points of view are not gained through the theory here set up of the action of chlorophyll, and through the proof of the influence of light upon the respiration of plants. In the already mentioned memoir (in my '*Jahrbücher für wissenschaftliche Botanik*'), with the preparation of which for the press I am now occupied, and which will bring into view the various forms of the hypochlorin needles, I hope to introduce some further details even in this direction.

#### BIBLIOGRAPHICAL NOTICES.

*A Manual of Palæontology for the Use of Students.* By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.G.S., &c. 2nd Edition. Revised and greatly enlarged. In two vols. Edinburgh and London: W. Blackwood and Sons, 1879.

THE study of fossil remains may be considered under different aspects—either in their biological relations, or in relation to the nature and succession of life in time, or as characteristic medals of different geological periods, or as explaining, from the known habits of closely-related forms, the conditions under which the various sedimentary formations were deposited. In whatever way we may wish to interpret them, a concise account of their nature and character is essential to the student of the life-history of the globe.

Few special treatises have been devoted to this subject, although notices of fossils occur in most geological text-books. The earlier works of Parkinson in 1811 and 1822, useful for their time, were twenty-two years later superseded by Mantell's '*Medals of Creation*' (1844-54), which in its turn was followed (1860-61) by the more special work on Palæontology of Prof. Owen. Based upon the same principle as the latter work, the first edition of Prof. Nicholson's '*Manual of Palæontology*' appeared in 1872, containing about 600 pages and 400 woodcuts.

With the exception of the omission of the last section, devoted to historical and stratigraphical geology, and which is, to some extent, embodied in the author's '*Ancient Life-History of the Earth*,' in general arrangement the present edition is similar to the former; but it has been so thoroughly revised, greatly augmented, and largely rewritten, with the addition of nearly double the number of woodcuts, that it may be considered almost a new work, comprising a comprehensive account of the leading



principles and facts of the vast and ever-increasing science of Palæontology.

The work is divided into three parts: the first part contains a general introduction to the study of palæontology, and treats of the characters, formation, and succession of the aqueous rocks, geological continuity and contemporaneous deposits, the conclusions to be drawn from fossils, the respective value of the vertebrates, invertebrates, and plants as tests of geological age and position of strata, and the general succession and progression of organic types, with a tabular arrangement of the leading subdivisions of the animal kingdom. Some additional matter is distributed in the six chapters forming this part, as regards fossilization, the condition and mode of occurrence of fossils (which might have been extended), the replacement of organic and other substances by silica and carbonate of lime. The chemical and organic origin of flint and limestones is fairly explained, as also that of phosphate of lime, either disseminated or concretionary in the sedimentary rocks due to organic agency; but this does not account for the veins of apatite or phosphorite in Spain, Norway, and other places; and it may be doubted how far the thick deposits of apatite in the Laurentian of Canada are directly due to vital agency. The origin of the red clay of the Atlantic depths (p. 25) has been attributed to other sources than the disintegration of the tests of Foraminifera. The "colonies" of Barrande (p. 53), like those stated to occur in the Lake district, may perhaps be otherwise interpreted than by the explanation given (p. 54), when the contained fossils or the physical structure of the district is further investigated.

The second part, comprising the history of the Invertebrata and Vertebrata, forms by far the larger part of the two volumes (chaps. vii. to xlviii.); and of these two divisions the former naturally occupy the greater space, on account of their state of preservation, their comparative abundance and general distribution in the sedimentary strata, and "especially upon the ground that palæontological students are, as a rule, much more largely interested with the former than the latter."

The six subkingdoms of the Invertebrata are treated in a somewhat similar manner, although not upon any absolutely uniform plan, as to the general diagnostic characters and the characters of their respective classes and orders, their distribution or range in time, and to the part which any of them has notably contributed to the formation of the solid crust of the earth. A short summary is generally given of the principal fossil groups, the object being to select "for notice and characterization those *leading types* of each great group of fossils which may seem to demand mention on the ground of their being *common*, or in other respects, geologically or zoologically, of peculiar importance."

This object is carried out in the successive chapters. The Brachiopoda, from their importance, are fully noticed, as also the Lamelli-branchiata; the characters of the chief groups and genera and their geological range are also given. In noticing the peculiar mode of

attachment of one species of *Productus* (p. 457), by the twisting of some of the spines of the ventral valve round the column of a crinoid, we may mention that Prof. King, in 1850, had shown that some forms of *Strophalosia* were attached to other bodies by their long umbonal spines.

The Gasteropoda, Pteropoda, Heteropoda, and Cephalopoda are described in the same manner as the preceding orders of Mollusca. Under the Cephalopoda a classificatory table is given, adopted by M. Favre, which is primarily based on the presence or absence of an aptychus, with the new subgeneric names introduced by Waagen, Suess, and others for the comprehensive genus *Ammonites*, which hitherto have not been introduced into text-books. Although now accepted, "it must be admitted that it is generally impossible to refer particular specimens to these sections, unless they are in a state of unusually complete preservation, or the observer be provided with a very extensive *suite* of examples of a given form."

In treating of *Eozoön* the author speaks with caution, although he gives fully the characters by which its organic nature has been recognized. While briefly alluding to the opinions as to its non-organic origin, Dr. Nicholson does not consider that the arguments of Möbius are by any means decisive.

Under the Cœlenterata the division "Tabulata" is still retained. Although, as stated in this work and the separate memoir on the same group noticed in this Journal (Nov. 1879), from the researches of Verrill and Moseley, the "Tabulate Corals" are a most diverse group, and have reference to a structure not characteristic of any natural one, still, says Dr. Nicholson, "there remain some extinct groups of corals which may, in the meanwhile, be retained to form the section *Tabulata*, though their true affinities and systematic position are matters of great doubt" (p. 199).

*Codaster* and *Codonites*, which make a close approach to *Pentremites*, are placed in the Cystoidea, as advocated by Billings, and may be regarded as transitional forms between that order and the Blastoidea, and thus extending the range of the Cystideans to the Carboniferous. In describing the older fossil Polyzoa, the author makes some remarks on the position of some fossils referred to *Chætetes*, *Monticulipora*, &c.; some of the forms described under these names he considers really Polyzoa, while the tabulate forms of these genera may be regarded as being Actinozoa. The Secondary and Tertiary Polyzoa are so numerous and varied that only a brief and general review of the leading groups is given. The structure of *Heteropora* is described at some length, as it is considered to have an important bearing on the structure and systematic position of *Chætetes*, *Fistulipora*, &c.

Under the Mollusca it might have been useful to have given the sectional divisions of the important genera *Trigonia* and *Inoceramus*, and also of *Nerinea*. It may be noticed that *Anomia* and *Cyrena* occur in the Jurassic strata; and that the subgenus *Trivia*, typified by *Cypræa europæa*, stated not to occur in a fossil condition (vol. ii. p. 22), is found in the Crag deposits.

The descriptions of the five classes of Vertebrata occupy twenty chapters; but, from the fragmentary condition in which their remains frequently occur, a more general account of each class is given, with definitions of the orders and a brief notice of the leading forms of each, except in cases of special interest, which are more fully described.

Under the class of Fishes the author notices the bodies called "Conodonts" from the older Palæozoic rocks, and which have been variously referred to Mollusca, Crustacea, and Fishes. The latter affinity, as originally suggested by Pander, is supported by Prof. Newberry, who is inclined to the view that they are really the minute teeth of Cyclostomatous fishes allied to the living Lampreys and Hag fishes. A similar opinion is held by Mr. Hinde (in a paper to the Geological Society), from the examination of a large number of specimens from the Cambro-Silurian and Devonian rocks of Canada and the United States, who considers, notwithstanding the differences in minute structure, we should not reject altogether the probability that they may have belonged to a similar low type of fishes as the existing Myxinoids.

The elevation of the Platysomoid fishes to the "rank of a distinct division of the Ganoids," as given at p. 138 on the authority of Dr. Traquair, *does not* coincide with the views of that author, as no such proposition occurs in the unpublished paper referred to by Dr. Nicholson in the footnote of the same page. On the contrary, Dr. Traquair (in a letter to the 'Annals,' Dec. 1879) holds "that the Platysomidæ, as a family, are not really allied to the Pycnodontidæ, but are, on the other hand, so closely linked to the Palæoniscidæ by ties of structure, that wherever we place the latter family, thither the Platysomidæ must follow."

The remarkable forms of Vertebrata lately described by Professors Cope and Marsh from the rich fossiliferous localities of the Western Territories, and which have so largely enriched the museums of Newhaven and Philadelphia, are noticed. Of these the most important are the Sauranodontia, Pteranodontia, and Dinosauria among Reptiles, the Tillodontia, Dinocerata, and Brontotheridæ of the Mammals, and the Odontornithes among the Birds—which latter group will probably receive further elucidation from the forthcoming memoir of Prof. Marsh.

The third part, containing four chapters, is devoted to Palæobotany; but scarcely any thing more is attempted than to give a brief and elementary sketch of the general distribution of plants in time, to which is added a short summary of the chief forms of vegetable life which more particularly characterize each of the great formations. The subject instead of being botanically is geologically treated; so that only the main features of the successive floras from the Pre-carboniferous to the Tertiary are noticed. But little new matter has been added to this part; so that the account of the Carboniferous, Permian, Triassic, Jurassic, and Eocene plants remains nearly the same as in the former edition.

The work is well printed; the 722 woodcuts, with a few excep-

tions, are generally excellent ; and, besides lists of the more important works relating to each great division, there is a useful glossary and copious index.

Notwithstanding every possible care, a text-book embracing so wide a field as the present one must occasionally present some shortcomings or omit some details which may be considered necessary ; still the subjects are placed before the reader in a clear and concise manner by the author, himself a practical geologist and experienced teacher, fully conversant with the requirements of the student ; and in this respect we consider he has succeeded in producing a very useful and well-arranged Manual of Palæontology. At the same time we cannot but regret that, even with the increased size and additional woodcuts, the publishers have so greatly advanced the price as probably to preclude its acquisition by some of those for whom it was specially intended.

*An Introduction to Animal Morphology and Systematic Zoology.*—

Part I. *Invertebrata*. By ALEXANDER MACALISTER, M.B. &c. 8vo. London: Longmans, 1876.

*An Introduction to the Systematic Zoology and Morphology of Vertebrate Animals*. By ALEXANDER MACALISTER, M.B. &c. 8vo. Dublin, Hodges ; London, Longmans, 1878.

THESE two books, although published at an interval of two years and under different titles, really constitute the two volumes of a single work. The author, no doubt for cogent reasons, having taken advantage of an offer, on the part of the Board of Trinity College, to bring out his second part as one of the “ Dublin University Press Series,” was compelled so to modify it and its title as to convert it into a separate treatise ; and although the existence of a first part without a formal successor is always to be regretted from a librarian’s point of view, we do not know that in the present case the students for whose use these books are specially intended need be very loud in their complaints.

The author’s motive in preparing this work was to furnish students with a text-book of animal morphology, compiled, as he himself tells us, from the most recent and authoritative writings upon the various groups of the animal kingdom. Thus he makes no pretence to originality, but has brought together from scattered sources the information that appeared to him necessary to convey a clear idea of the structure of animals, and the classification founded upon its peculiarities and differences, in order, as he says himself, to bridge over, as far as practicable, that gap which he finds not unnaturally to exist between ordinary manuals of zoology and the “ monographic literature ” of the subject. That he has done this with considerable success must be admitted ; and the success is well deserved ; for the labour expended in bringing together such a mass of material must have been immense, even leaving out of consideration the further task of working up the materials when collected into a compact whole, in the mode of performance of which we see

evidence enough that Prof. Macalister has, as he tells us, been "engaged in the practical study of comparative anatomy" for many years.

The author commences with some general remarks on the general structural phenomena of animals, which occupy his first six chapters. In these he describes protoplasm and its derivatives, and the nature and grouping of organs, treats of the general principles of histology and tectology, and the phenomena directly or indirectly pertaining to reproduction. These chapters, in fact, constitute a general introduction to the more special portion of the treatise, in which the application of the principles thus laid down to the different groups of animals is explained.

Of course the value of a treatise of this kind depends in great measure upon the classification adopted; and in this respect Prof. Macalister's book offers little at which any one can cavil. In his general classification he admits eight great subkingdoms—namely, Protozoa, Porifera, Coelenterata, Echinodermata, Vermes, Mollusca, Arthropoda, and Vertebrata; and although he places the Porifera among Metazoa, he recognizes their wide difference from the Coelenterata, with which, as is well known, some naturalists are inclined to associate them very closely, by ranging them in a distinct sub-series, Polystomata, as opposed to the rest of the Metazoa, which he denominates Monostomata. The recognition of the Echinodermata as a distinct subkingdom is certainly a step in the right direction from a morphological point of view; but the Vermes, including the remainder of Prof. Huxley's Annuloida, with the addition of the Bryozoa and the Tunicata, is a sufficiently heterogeneous mixture. This subkingdom Vermes in the hands of modern zoologists takes the place of the Radiata of the older writers as the "dust-heap" of the zoological domain; it is to be hoped that it may ere long be satisfactorily sifted and sorted.

In the general classification of the Vertebrata the author has followed Prof. Huxley; that is to say, after adopting Hæckel's division of the Vertebrate subkingdom into Acrania (including only *Amphioxus*) and Craniota, he divides the latter great group into Ichthyopsida, Sauropsida, and Mammalia—the first including fishes and Amphibia, the second the reptiles and birds.

The subordinate classification, with indications of characters, is carried in all cases as far as the orders, sometimes to the families, or the latter are indicated and typical examples cited. As might be expected in a book which is a reflex of the most recent writings on zoological matters, there is a tendency to multiply these lower groups; but as the author does not dwell specially upon them, or discuss their morphological peculiarities in detail, this is perhaps of the less consequence. Still we cannot but think that the adoption of fourteen orders of insects is a mistake, and, still more, the division of the Carinate birds, after Huxley's example, into eighteen orders.

Nevertheless to the earnest student such defects as these will be of little consequence; perhaps, indeed, it may be even an advantage to him to have the most recent opinions of English anatomists upon

matters of classification brought prominently before him, although, especially in the case of the birds, it would have been well if the author had indicated that a very different systematic arrangement of those animals was adopted by most practical ornithologists.

Prof. Macalister's descriptions of the anatomical structure of the different great groups of animals are more precise and detailed than we are accustomed to see them in English manuals; and to these he has added particulars as to the modes of development observed in the different classes and orders, and even, in many cases, short notes upon the habits and mode of life of the animals composing these groups. In fact, by the adoption of a very concise and matter-of-fact style, and by printing details in a smaller type than the main facts of his work, our author has contrived to compress into his two volumes an enormous amount of valuable information. Partly for the sake of brevity, and partly with the view of explaining the numerous technical terms which have been introduced of late years into zoological literature, Prof. Macalister has employed these very freely, and indeed has incurred some small amount of blame at the hands of some of his critics, on account of the multitude of "hard words" with which his work literally bristles on every page. The blame, however, does not seem to us to rest with him, but rather with the ingenious inventors of these multifarious terms, who seem to imagine that not only every organ, but almost every part or modification of an organ must have its distinct name. Our author has endeavoured, to the best of his power, to furnish his readers with a guide to these names and their interpretation; and for this, as for the excellent general statement of morphological facts which he has produced, we think that students owe him a debt of gratitude.

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## MISCELLANEOUS.

*The Sea-weeds of Salt Lake.* By A. S. PACKARD, Jun.

THE attention of the visitor to the shores of the Great Salt Lake, Utah, is sometimes attracted by the small masses of Algæ which are seen to be suspended in the brine, and to be cast ashore in little wind-rows on the sandy shores. Four years ago, while connected with Hayden's U.S. Geological Survey of the Territories, I made an investigation of the life of the Great Salt Lake, especially of *Artemia fertilis* and *Ephydra gracilis*, and took pains to collect in alcohol, and also dry, specimens of these Algæ, as they had been unnoticed by botanists and collectors so far as I am aware. It is probable that these Algæ are almost the only source of food for the brine-shrimp, as they are diffused through the water in nearly equal abundance with the crustaceans themselves, and in no case, that I could see, grow attached to any objects in the lake or on the shore. The most common form (*Polycystis*) is a rounded, lobulated, green mass which lives suspended in the water.

Specimens of the Algæ collected were sent to Prof. W. G. Farlow, of Harvard University, from whom the following preliminary report has been received :—

“ The Algæ which you collected in Salt Lake are very interesting, and, as far as I know, are the first which have ever been collected in that locality. Mr. Sereno Watson, the distinguished botanist of the King Survey, tells me that he examined a portion of Salt Lake for Algæ, but without success, and thinks it probable that very few plants will be found in the lake. The specimens you sent comprise two small packages of dried material and a small bottle of alcoholic specimens. The alcoholic material is scarcely determinable, as the specific characters of Algæ, such as would be expected to occur in Salt Lake, are generally lost by immersion in alcohol. The dried material I have soaked out and examined.

“ It consists largely of grains of sand and remains of small animals, mixed with which are three species of Algæ. The most abundant Alga is one which forms irregular gelatinous masses, sometimes attaining a diameter of half an inch. The colour, apparently much faded in drying, is brownish with a tinge of bluish green\*. It seems to me to be a species of *Polycystis*; and I am unable to refer it to any of the described species, and have called it provisionally *Polycystis Packardii*. Its distinguishing characters are the oblong shape of its cells, which are smaller than in any of the marine species of the genus which I have examined, and the firmness and lobulated form of the gelatinous substance in which they are imbedded. Besides the *Polycystis* there is a species of *Ulva*, using the word in the extended sense adopted by Le Jolis, which is in fragments, so that one can form no very accurate idea of its habit. The microscopic characters, however, show that it is, with scarcely any doubt, *Ulva marginata*, Ag., found on the coasts of Europe. The specimens from Salt Lake agree very well with specimens from the French coast which are considered by Le Jolis to be the species described by Agardh. The third Alga from Salt Lake is much less abundant than the others in the packages sent, and is also in poor condition for comparison with herbarium specimens. It is a species of *Rhizoclonium*; and it comes very near to *R. salinum*, Ktz. (*R. riparium*, Harv.), a common marine species of this country and also found in Europe near salt springs. The Salt-Lake plant has smaller cells and approaches *R. Kochianum*, a species also marine and found in saline regions.

“ You will see, then, that two of the three species are recognizable as marine forms, while the third, in my opinion new, is at least not to be referred to a known marine form. As a rule, the Algæ found in saline regions belong to species found in brackish waters on the coast. One might expect to find a large variety of Ulvæ and Conferveæ in Salt Lake; and it would be of interest to see how closely these inland forms approximate to the littoral forms of the eastern and western coasts.”—*Amer. Nat.*, Nov. 1879.

\* The colour in life is an olive-green.—A. S. P.

*Observations upon the Artificial Fertilization of Oyster-eggs, and on the Embryology of the American Oyster.* By W. K. BROOKS, Associate in Biology, Johns Hopkins University.

All the writers upon the development of the oyster, from Home (Phil. Trans. 1827) to Möbius (Austern und Austernwirthschaft, 1877), state that the eggs are fertilized inside the shell of the parent, and that the young are carried inside the mantle-cavity until they are provided with shells of their own, that they leave the parent in a somewhat advanced state of development, and that their free-swimming life is of short duration and lasts only until they find a suitable place to attach themselves.

Misled by these statements, which do not apply to our species, I opened a number of oysters during the summer of 1878 and examined the gills and the contents of the mantle-chambers for young, but found none, and concluded that the time during which the young are carried by the parent must be so short that I had missed it. I undertook the same investigation this May, with the determination to examine adult oysters for young every day during the breeding-season, and at the same time to try to raise young for myself by the artificial fertilization of eggs taken from the ovaries. I had complete success with the second method from the first, and succeeded in raising countless millions of young oysters, and in tracing them through all their stages of development up to the time when they had acquired all the characteristics which Salensky, Lacaze-Duthiers, Möbius, and others have figured and described in the young European oyster at the time it leaves its parent. I also made careful examination of the gills and mantles of more than a thousand oysters, but never found a single fertilized egg or embryo inside the mantle-cavity of an adult, although I found females with the ovaries full of ripe eggs, others with the ovaries half empty, others with them almost entirely empty, and others at all the intermediate stages; and I therefore feel sure that my examinations were made upon spawning oysters.

While this evidence is only for one season and one bed, I think that, until it is shown to be exceptional, we must conclude that there is an important difference in the breeding-habits of American and European oysters, and that the eggs of the American oyster are fertilized outside the body of the parent—that during the period which the European oyster passes inside the mantle-cavity of the parent, the young American oyster swims at large in the open ocean.

The more important points in the development of the oyster are:—

1. The oyster is practically unisexual, since at the breeding-season each individual contains either eggs or spermatozoa exclusively.

2. Segmentation takes place very rapidly, and follows substantially the course described for other Lamellibranchs by Lovén and Fleming.



3. Segmentation is completed in about two hours, and gives rise to a gastrula, with ectoderm, endoderm, digestive cavity and blastopore, and a circle of cilia or velum. At this stage of development the embryos crowd to the surface of the water and form a dense layer less than  $\frac{1}{4}$  inch thick.

4. The blastopore closes up; the endoderm separates entirely from the ectoderm; and the two valves of the shell are formed, separate from each other, at the edges of the furrow formed by the closure of the blastopore.

5. The digestive cavity enlarges and becomes ciliated; and the mouth pushes in as an invagination of the ectoderm at a point directly opposite that which the blastopore had occupied. The anus makes its appearance close to the mouth.

6. The embryos scatter to various depths, and swim by the action of the cilia of the velum. The shells grow down over the digestive tract and velum; and the embryo assumes a form so similar to various, marine Lamellibranch embryos which are captured by the dip-net at the surface of the ocean that it is not possible to identify them as oysters without tracing them from the egg. The oldest ones which I succeeded in raising in aquaria were almost exactly like the embryos of *Cardium* figured by Lovén.

7. The ovaries of oysters less than  $1\frac{1}{2}$  inch in length, and probably not more than one year old, were fertilized with semen from males of the same size, and developed normally.

An illustrated paper on the embryology of the oyster, with a detailed account of my observations, will be published, shortly, in the Report of the Maryland Fish Commission for 1879.—*Amer. Journ. Sci. and Arts*, December 1879, pp. 425-427.

*Observations on the Salivary Glands of the Echidnas.*

By M. H. VIALLANES.

From the anatomical arrangement of the different glandular masses which produce the saliva we may distinguish in the Echidna the three groups of glands which are met with in most Mammalia, namely:—1, the *parotid glands*; 2, the *submaxillary glands*; 3, the *sublingual glands*.

The parotid glands, which are so constant in the Mammalia, escaped the notice of Cuvier and R. Owen; the latter even formally denies their existence. I have found the parotids well developed in the Echidna; but instead of being situated in front of the auditory passage, they are situated far back, at the middle of the neck.

In the Echidna there are on each side two submaxillary glands—one deep-seated, the other superficial. The deep-seated submaxillary gland has been well described by Cuvier and Owen. Its excretory duct passes directly forward, and pierces the great transverse muscle which forms the superficial layer of the floor of the mouth.

It is at this point that it receives the excretory duct of the superficial submaxillary gland.

The superficial submaxillary gland is a glandular mass of a rose-colour, and of an oval form, a little larger than the parotid, situated immediately beneath the skin, and applied against the pectoral muscle. The excretory duct which it emits is 9 centims. long; it runs forward, crossing the sterno-mastoidian, and opens into the excretory duct of the deep-seated submaxillary at the point already indicated. The superficial submaxillary gland is the first that makes its appearance when an *Echidna* is deprived of its skin; it has, however, hitherto escaped the notice of anatomists.

The common excretory duct of the deep-seated and superficial submaxillary glands presents a most remarkable arrangement, which escaped the notice of Cuvier and Duvernoy. This arrangement has been partially described by Owen, who regards it as unique in the class *Mammalia*.

The excretory duct, after having slightly dilated, passes forward, describing certain flexuosities and diminishing pretty rapidly in size. After having skirted the inner margin of the inferior maxillary, it reaches the symphysis of the chin. From its inner side lateral branches are given off, which, in their turn, divide several times, and open upon the floor of the mouth by very numerous orifices arranged in a single longitudinal row stretching from the base of the tongue to the symphysis of the chin.

I have had the good fortune to be able to examine the fleshy parts of the head of the New-Guinea *Echidna* (*Acanthoglossus Bruijnni*), a species still so rare that the Museum of Paris alone possesses the few individuals at present known. In this we find the arrangement of the terminal part of the excretory duct of the submaxillary glands vary a little. This duct swells into a fusiform reservoir, with very glandular walls, especially behind, extended from the base of the tongue to the symphysis. From the inner surface of this reservoir issue four or five secondary ducts, which open directly upon the floor of the mouth.

With regard to the sublingual glands, I have nothing to add to the observations of Cuvier, who described them for the first time. They seem to have escaped the notice of Prof. Owen.—*Comptes Rendus*, November 24, 1879, p. 910.

#### *American Jurassic Mammals.*

Prof. Marsh has recently described some additional remains of Mammals from the Jurassic strata of the Rocky Mountains. One of the most interesting is the *Ctenacodon serratus*, which agrees in its main features with the genus *Plagiaulax* of Falconer. The others are *Dryolestes arcuatus*, *Tinodon robustus*, and *T. lepidus*. These forms, as well as those already described, show a great resemblance to known types from the Purbeck beds of England.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

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VII.—*On some Blind Amphipoda of the Caspian Sea.*  
By Dr. OSCAR GRIMM\*.

THE problem of the origin and evolution of blind animals has occupied the attention of many naturalists of late; and their investigations have contributed to science many facts of the greatest importance. The number of these discoveries has been further increased by the deep-sea investigations, which have brought to light some extremely interesting forms from enormous depths. But when we consider the already great number of blind animals, we cannot help constantly raising the question of their origin, as even now two opposite opinions prevail, which exclude each other and cannot be reconciled.

Twenty years ago one might have been contented with the dogma that the creatures were created blind because they were intended to live in dark caves and the abysses of the sea, and therefore the faculty of sight was unnecessary to them. Nowadays, however, this notion is supported by few professed naturalists: the great majority recognizes in the absence of eyes in certain animals the result of a residence in darkness, by which means the visual organ must certainly become retrograde, as it cannot be and is not made use of. Besides Fries's experiment with *Gammarus pulex*, it is well known that persons who have been compelled to languish out a long

\* Translated by W. S. Dallas, F.L.S., from the 'Archiv für Naturgeschichte,' 1880, p. 117.

series of years in dark prisons have lost the pigment of their eyes, and when brought once more into the open could not for a long time distinguish objects, but rather suffered pain from the daylight, as also that "in many blind people the eyes have literally disappeared. In the bodies of men who were perfectly blind when alive we even find that the optic nerve has disappeared up to the brain, *i. e.* transformed into a mass which contains no visual-nerve fibres" (Stricker, 'Studien über das Bewusstsein,' p. 54). Thus it appears very natural that animals which live in dark caves, wells, sea-abysses, or in the earth itself should lose their power of vision, their eyes being reduced to almost nothing—as, indeed, is indicated by the fact that eyes are often still present although only rudimentary, such as we find, for example, in *Sorex* and *Talpa*.

But we know that in the depths of the sea where some eyeless animals occur, whose deprivation of eyes is explained by the darkness prevailing in those abysses, there also exist forms which have not merely ordinary eyes, but unusually developed, large, prominent, and strongly pigmented eyes. Nay, the *Gnathophausia* of the 'Challenger' Expedition, coming from a depth of from 1830 to 4020 metres, actually possesses pedunculate eyes, and, besides these, ocelli on the maxillæ; the *Memida* from a depth of 1000–1200 metres has well-developed and exceedingly sensitive eyes; while *Gammaracanthus caspius*, mihi, from a depth of 108 fathoms in the Caspian, *Boeckia spinosa*, *nasuta*, and *hystrix*, mihi, from depths of 70–150 fathoms in the Caspian, and various species of *Mysis* from the same sea and from depths down to 500 fathoms, all have well-developed, large, prominent, and black-pigmented eyes. This sufficiently proves that at the depths indicated the visual organ can be and is made use of, as here absolute darkness does not prevail, but only a dark night. We have only to remember that nocturnal animals, such as the owls, predacious mammals, &c., possess very large and well-developed visual organs (in fact, eyes adapted to the darkness), to explain the established fact that the depths of the sea are inhabited by crustaceans in which the visual faculty is enormously increased. But seeing that, as has been said, forms of animals also exist in the same abysses whose eyes are but slightly developed or unpigmented, or even appear completely reduced to a rudimentary condition, it is evident that the explanation that the retrogression of the eyes is produced by living in the depths of the sea is not sufficient.

In the Caspian Sea, at 0° 12' E. long. (from Baku) and 39° 51' N. lat., I obtained in a single cast of the dredge ten new species of Gammaridæ (namely *Gammarus paxillus*, *G.*

*crassus*, *G. Gregrokowii*, *G. portentosus*, *G. coronifer*, *G. thaumops*, *Pandora caeca*, *Iphigeneia abyssorum*, *Gammaracanthus caspius*, and *Amathilinella cristata*), all of which are furnished with eyes, but in very different degrees of development: thus *Gammaracanthus caspius* has very large round eyes, *Gammarus coronifer* and *Amathilinella cristata* long but narrow eyes, *Gammarus thaumops* triangular unpigmented eyes, and *Pandora caeca* small unpigmented eyes, which can hardly be endowed with the faculty of sight. A still better example is furnished by the following new Amphipoda discovered by me in the Caspian Sea:—

	from the depth of	fathoms.
<i>Onesimus caspius</i>	75-250	
— <i>pomposus</i>	" "	180
— <i>platyurus</i>	" "	40-48
<i>Pantoporeia microphthalma</i>	" "	80-90
<i>Niphargus caspius</i>	" "	35-90

of which the last two species, together with *Onesimus caspius*, were also taken in one cast, and, indeed, at a depth of 80-90 fathoms, at 0° 36' E. long. and 41° 6' N. lat. *Pantoporeia microphthalma* and *Niphargus caspius* possess pigmented but small eyes; of the species of *Onesimus* some possess red, others (*O. caspius*) perfectly unpigmented eyes, which, in the last-mentioned species at least, are deprived of the faculty of sight; and with these more or less blind species there live Mysidæ, the large, convex, and black eyes of which certainly absorb a sufficiency of light even in the darkness of the depths.

These examples may suffice to show that deep-sea existence alone does not of necessity cause the retrogression of the visual organ. Now, however, we will show from our Caspian Amphipoda, how the animals stand related to the sea-depths, how deep-sea existence acts upon their organization, by what essentially the disappearance of the eyes is brought about, and by what the latter are replaced in the event of their retrogression.

We may accept it as proved that with the increase of the depth of the sea the quantity of rays of light diminishes, so that at a certain distance from the surface the strength of the light is very small, although it never falls to zero. But, however weak the light may be, the possibility of vision is not excluded, and the eyes of animals living in the abysses need only to be adapted to the comparative darkness\*. Such

\* I think it doubtful that absolute darkness commences at a depth of 100 metres, as found by Forel in the lake of Geneva; for I cannot at all conceive of absolute darkness. I readily admit that at this or the other depth the daylight no longer reacts upon certain chemicals; but this does not exclude the possibility of seeing.

appears to be the case with the large, gibbose, dark eyes of Caspian Mysidæ, of *Gammaracanthus caspius*, the species of *Boeckia*, &c. It is, however, conceivable that in many animals in the persistent darkness the eyes do not become developed and are replaced by other organs of sense. In the latter case the eyes may even become degenerated, and the more rapidly and completely the less they are used, the less the service they render or are capable of rendering to their possessor. We may take as examples *Niphargus caspius*\* and the above-mentioned species of *Onesimus*.

In examining these we find highly developed sense-organs, which probably function not only as organs of touch, but also (at least in the species of *Onesimus*) as organs of taste †.

Besides small, but dark-pigmented eyes, which can probably hardly function at depths of 35–90 fathoms, and which must be regarded as the remains of eyes which formerly functioned, *Niphargus caspius* has exceedingly well-developed organs of smell and touch on the antennæ, and especially on the upper ones. At the same time it is to be remarked that the males, which have the smaller eyes, possess a greater number of these sense-organs than the females, which, with respect to other characters also, *e. g.* the number of joints in the secondary

\* From this species *N. puteanus* is probably derived. It is possible that it is identical with *N. ponticus*, Czern.; unfortunately I have been unable rightly to determine the latter, as the description which M. W. Czernjewsky has given of it appears to be very defective. (See his 'Materialia ad monographiam ponticam comparatam.') It must, however, be remarked that our *N. caspius* differs in many respects from the other species of *Niphargus*, and, indeed, from *N. puteanus*, as in its shorter antennæ, the differently formed hand of the last pair of limbs, &c.; so that, perhaps, our species may be regarded as the representative of a new genus between *Niphargus* and *Gammarus*. I do not take this course, however, and recognize in the different organization of *M. puteanus* the expression of a further development under the influence of certain conditions, which have superinduced the deficiency of the eyes and, at the same time, the greater development of the antennæ which bear the sense-organs that take the place of the eyes. In any case, *Niphargus caspius* appears to be the older form, which has maintained itself (perhaps somewhat altered) in the Caspian down to the present time, just as other species of the Tertiary period still continue to exist there, as I have indicated in my 'Kaspischen Fauna,' Lief. ii., in the case of *Dreissena rostriformis*, *D. Brardii*, *D. caspia*, *Cardium catillus*, *Planorbis micromphalus*, &c. *Niphargus caspius* is very probably the "extinct Gammarid" (see Leydig, "Ueber Amphipoden und Isopoden," Zeitschr. f. wiss. Zool. xxx. p. 249) which the other species of *Niphargus* have as their ancestor.

† In many cases, no doubt, it is difficult to decide whether a certain organ is adapted to feeling, tasting, or hearing; nay, it is exceedingly probable that in many of the lower animals the faculty of touch is not separated from taste and hearing.

flagella, more resemble the species of *Gammarus*, and thus represent the more conservative element, which, indeed, is the case with the female sex generally. On the first four joints of the five-jointed main flagellum of the upper antennæ of the male are very large cylindrical organs, described by Leydig and others as olfactory organs. At their free extremities these cylinders present each an aperture, from which perhaps, as Leydig states, thin hairs may actually be exerted; and from within a nervous branchlet penetrates into each cylinder, and forms a cellular inflation (in the cylinder itself) only to disappear immediately afterwards, as I have observed still better in living examples of another species, namely *Gammarus priscus*, at Krasnovodsk. On the secondary flagellum of *Niphargus caspius*, as also on the last joint of the peduncle of the inferior antennæ, we find peculiar organs, constructed like the olfactory pencils of *N. puteanus*, as described by Aloïs Humbert: these are large and resistant rods, the somewhat acute extremities of which are beset with a great number of very thin and long chitinous hairs. In the interior of each such rod runs a nerve, which, before entering into the rod, swells into a nerve-cell with a nucleus. But whether this nervous branchlet breaks up into still finer ones, which penetrate into the chitinous hairs, I have been unable to see, although I have employed a magnifying-power of 1500 diameters and various reagents. From their organization I should not interpret these pencils as essentially and exclusively auditory organs, but as extremely sensitive organs of touch, capable of perceiving the very slightest movement of the surrounding medium.

These olfactory and tactile (or auditory) organs, which are certainly comparatively very highly developed, may enable the animal to dispense with eyes in the dark sea-depths inhabited by it; and they are thus in course of degeneration, although they have not yet completely disappeared—in part, perhaps, because they may still be made use of, for example, in ascending to depths of 35 fathoms.

Matters are very different with the species of *Onesimus*, of which we may take for consideration *Onesimus caspius* as the most typical.

The eyes of *Onesimus caspius* are small, irregularly oval, widely separated from each other, and completely unpigmented, so that they are not at once distinguishable even under the microscope. It is well known that the unpigmented eyes of many Gammaridæ living at great depths become reddened under the action of sunlight; but this does not occur in *O. caspius*. We are justified in assuming that even if the species

of *Onesimus* are not entirely deprived of the faculty of sight, their eyes do not function in the medium which usually harbours them, *i. e.* in the submarine mud where they constantly dwell.

But leaving out of consideration the undeveloped eyes, we find in the species of *Onesimus* no sense-organs on the antennæ and other external parts of the body, as in *Niphargus*. Nay, the antennæ are in them even deprived almost entirely of the usual hairs, which occur only on the lower surface of the upper, and the upper surface of the inferior antennæ, and are also very minute and present in small number. On close examination, however, we find very highly developed, although concealed, sense-organs on the outer lamellæ of the maxillipedes, which have already been described or figured by different authors. These are short thick stumps with rounded ends, which stand in corresponding cylindrical depressions of the lamella, from which they usually have only the rounded portion projecting. Some of them, however, appear much longer, inasmuch as they project more and also have the extremities more acute; these are the two cylinders standing at the apex of the lamella, which present a transition towards the ordinary setæ, and thus also prove that we have to do with chitinous setæ metamorphosed for a particular purpose\*. These taste-cylinders (as I will call them) stand in a row along the inner margin of the lamella, their number varying from eight to fourteen in the different species, as also probably according to the age of the individuals. In the interior of the lamella, beneath the oval matrix-cells, there runs a thick nerve-cord which sends off a branch nerve to each taste-cylinder; these branches are slightly thickened at their entrance into the cylinder, and are afterwards completely lost; but whether they form a cell in the thickened part, I have been unable to decide†. At any rate the sensitive nature of

\* Similar tactile hairs with more or less developed nerves and nerve-cells occur ordinarily on the parts of the mouth of the Arthropoda—for example, among the Diptera, as is universally known. But where Prof. Wagner has detected a number of buccal apertures ("Polystomien") among them is hard to conceive, as is also the case with the "resucking" (Wiedersaugung) of the food (analogous to rumination!) by flies, also discovered by him. However, as Wagner has found epithelial cells in the saliva of a materialized spirit, and examined the hair of a Chinese lady called up from the spirit-world (with a view to the discovery of the ancestors of the existing Pediculidæ?), we may expect any thing from him (see Wagner's and Bautleron's spiritualistic writings in the 'Russischer Bothe').

† For the investigation of these cylinders *Onesimus platyuros* and *O. pomposus*, as larger species, are more convenient than *O. caspius*; but, unfortunately, I have only a few specimens of those species.



these cylinders is so distinctly marked, that we are certainly justified in regarding them as tactile organs, and, from their position, also as organs of taste.

Thus we see that in the species of *Niphargus* and *Onesimus*, which are either blind or furnished with imperfectly functioning eyes, the defective faculty of sight is replaced by the augmented function of other organs, and even brought about thereby, in so far as these render the eyes not indispensable and their retrograde metamorphosis therefore possible. The question now arises how it happens that in the different genera different organs come to greater development; and this question is answered by observation of their life-phenomena. During my dredging investigations I have observed that the species furnished with sensitive antennæ, such as *Niphargus caspius*, although living at great depths, live in the water and not in the mud, which is proved not only by experiment after the animals have been brought up\*, but also by the fact that all individuals of the *Niphargus* are greatly infested by *Vorticellæ*.

The species of *Onesimus* behave quite differently. They live constantly in the mud of the sea-bottom, and here, burrowing quickly like moles, seek their nourishment by consuming the mud which contains particles of organic matter. As a matter of course, antennæ furnished with sensitive organs can be of no service to them, since not only such delicate and fragile structures as the olfactory cylinders and pencils, but even the coarser bristles have disappeared from the outer surfaces exposed to friction against the mud, as we have already stated by indicating that in *Onesimus* such bristles exist only on the inner surfaces of the antennæ, which protect each other. But as external sense-organs could not be developed, the more concealed parts of the body had to be provided with such organs. We have already seen that in the species of *Onesimus* the setæ of the outer lamellæ of the maxillipedes are developed into sensitive organs; and although it is not yet decided whether they represent taste-organs, we cannot avoid regarding them as organs adapted to the determination of the quality of the food, which, in the subterranean life of these animals, replace the eyes, and thus also bring about their retrograde metamorphosis.

We may briefly summarize all that has been said as fol-

\* The animals brought up by the dredge were always placed, first of all, in small basins of water for the purpose of the observations above indicated: but the relation of the animals to the mud is to be seen even in the dredge itself; the water-animals (as opposed to the mud-animals) do not bury themselves deeply in the mud, and are speedily suffocated in it.

lows :—In the depths of the sea, where a darkness approaching zero, although not absolute, prevails, the animals living there are either provided with highly developed organs of sight, or the eyes are replaced by other organs which acquire a considerable development. These organs, however, are developed upon different parts of the body in accordance with the external conditions and the mode of life of the animal, which must be regarded as the *primum movens* of the whole process of the degeneration of the one organ and the development of the other.

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### VIII.—On the Genera of Felidæ and Canidæ.

By E. D. COPE.

[Continued from p. 45.]

#### Canidæ.

THE range of variation presented by the species of Canidæ includes several generic divisions, recent and extinct. These genera, however, are as closely intergraded as are those of the cats; and their definite characters are subject to occasional failure from abnormal variations. These, however, are not so frequent as to invalidate the classification to which they form the exceptions.

The Canidæ appeared in the Upper Eocene period; and the genus *Canis* was well represented by species in the lowest Miocene in Europe and the United States. The other genera are represented by fewer species; and many of them are extinct. The foxes (*Vulpes*) are the most numerous of them; and but few extinct species of them are known. America presents us with the greatest variety of genera, as *Enhydrocyon*, *Temnocyon*, and *Palæocyon* extinct, and *Icticyon*, extinct and recent. *Speothus*, extinct in America, still exists in Asia.

The most complete catalogue of the species of Canidæ is that of Dr. Gray. In his work the author brings together observations of various naturalists, and adds a number of his own. He admits a large number of generic divisions; but many of these, like those of his Felidæ, are simply founded on specific characters. A few good genera, however, exist; and a synopsis of their characters is given below. The genus *Megalotis* is here excluded from the Canidæ on account of the

unspecialized character of the superior sectorial tooth, as is done by Dr. Gray.

- I. True molars  $\frac{3}{3}$ .  
Premolars  $\frac{4}{4}$ ; inferior sectorial with internal tubercle. *Amphicyon*.
- II. True molars  $\frac{2}{4}$ .  
Premolars  $\frac{4}{4}$ ; inferior sectorial with internal tubercle. *Thous*.
- III. True molars  $\frac{2}{3}$ .
  - a. Premolars  $\frac{4}{4}$ .
    - β. Inferior sectorial without internal tubercle.  
Heel of sectorial cutting ..... *Palæocyon*.
    - ββ. Inferior sectorial with internal tubercle.
      - γ. Four toes in the manus.  
A sagittal crest ..... *Lycaon*.
      - γγ. Five toes in the manus.
        - δ. Heel of sectorial simply cutting.  
A median sagittal crest (? toes) ..... *Temnocyon*.
        - δδ. Heel of sectorial concave, with raised borders.
          - Pupil round; temporal fossa with simple superior border ..... *Canis*.
          - Pupil erect; temporal fossa with simple superior border ..... *Vulpes*.
          - Pupil erect; temporal fossa bounded above by a rib-like crest ..... *Urocyon*.
    - aa. Premolars  $\frac{3}{3}$ .  
Inferior sectorial with internal tubercle and cutting heel ..... *Enhydrocyon*.  
Inferior sectorial with internal tubercle and wide tubercular heel ..... *Tomarctus*.
  - IV. True molars  $\frac{2}{2}$ .
    - a. Premolars  $\frac{1}{4}$ .  
Inferior sectorial with internal tubercle ..... *Speothus*.  
Inferior sectorial without internal tubercle (superior molar sometimes one) ..... *Synagodus*.
    - aa. Premolars  $\frac{2}{2}$ .  
Inferior sectorial without internal tubercle (incisors caducous) ..... *Dysodus*.
  - V. True molars  $\frac{1}{2}$ .  
Premolars  $\frac{4}{4}$ ; inferior sectorial with internal tubercle. *Icticyon*.

It is discoverable that the series represented by the above genera is a part of the greater line of the digitigrade Carnivora, embracing the greater part of it, which is less specialized than, or inferior to, the part covered by the Hyænidæ and Felidæ. Without entering into the relations of the Canidæ with the civets and Mustelidæ, it may be remarked that the genera display a successive reduction in the number of premolars and molars from the more ancient to modern geologic times. It is interesting to note that the genera presenting the greatest reduction in all respects (*Synagodus* and *Dysodus*) are now only known in a domesticated condition. Another reduction is seen in the number of tubercles of the inferior sectorial.

## AMPHICYON, Lartet.

This genus is better represented in Europe than in North America, but two species being certainly known from the latter. No recent species.

THOUS, Gray. *Dusicyon*, Smith (nomen nudum).

Existing species of South America only.

## PALÆOCYON, Lund.

Extinct species of South America only.

## LYCAON, Brooks.

Existing species of Africa only known as yet.

## TEMNOCYON, Cope.

(Proceedings Amer. Philosophical Society, 1878, p. 68.)

In this genus the heel of the inferior sectorial tooth rises into a single more or less median crest; in *Canis* the corresponding front is basin-shaped, with tubercles on each side. The superior molars of the typical species (*T. altigenis*) are unknown; but those of a new species, described below, do not differ from those of the genus *Canis*. The *Cynodictis crassirostris* of Filhol, from the French Phosphorites, approaches this genus.

*Temnocyon coryphæus*, sp. nov.

This is the most abundant dog of the Truckee beds of the John-Day country. I have identified it heretofore as my *Canis Hartshornianus*; but I find, on examination of the inferior sectorial tooth, that it is a species of *Temnocyon*. This genus was characterized by me on evidence furnished by a mandible of a species which I named *T. altigenis*\*, which is of considerably larger size than the present one, but which agrees with it in the presence of a cutting-edge instead of a basin on the heel of the inferior sectorial. The *C. Hartshornianus*, known as yet from few fragments, is intermediate in dimensions between these two.

Several crania and more or less of the skeleton of the *T. coryphæus* are present in my collection. A nearly perfect skull displays the following characters:—The orbits are entirely anterior to the vertical line dividing the skull into halves; and the muzzle is proportionately shortened. It is also narrowed anteriorly; and its median line above is shallowly grooved. The interorbital region is greatly convex to

\* Proceedings Amer. Philosoph. Soc. 1878, viii. p. 68.

the supraorbital region, and is grooved mesially. The post-orbital processes are mere angles, and are flattened from below. The cranium is much constricted behind the orbits, where its diameter is not greater than the width of the pre-maxillary incisive border. The sagittal crest is much elevated, and forms a perfectly straight and gradually rising outline to its junction with the incisor. The borders of the latter are very prominent, extending backwards considerably beyond the brain-case. The zygoma is rather slender, is elongate, and but little expanded. The otic bullæ are very large; the paroccipital processes are directed backwards, at an angle of  $45^{\circ}$ , and are rather elongate and acute; they cap the bullæ posteriorly. The lateral occipital crests bound a fossa of the occipital region near the condyles. The occipital surface is directed horizontally backwards above the foramen magnum. This part of it, and its superior portion, are divided by a median keel.

The basioccipital is keeled on the middle line below. The sphenoid is not keeled, and is concave, its borders descending on the inner side of the bullæ. The pterygoid fossa is rather narrow, and the hamular process is short. The posterior border of the palate does not extend anterior to the posterior edges of the last tubercular molar; and its middle portion projects backwards in a triangular process. The palatine fossa for the inferior sectorial is shallow. The superior surface of the postorbital region is roughened.

The *foramen infraorbitale exterius* is rather large, and issues above the anterior border of the sectorial tooth. The *f. incisiva* are short, not extending posterior to the middle of the canines. The *f. palatina* are opposite the posterior border of the sectorial. The *f. lachrymale* is altogether within the orbital border. The *f. opticum* is rather large. This species is peculiar in having the *ff. spheno-orbitale, rotundum, and alisphenoidale anterius* united into one large external orifice. The alisphenoid canal is larger in *Canis latrans*, and its posterior foramen small. The *f. ovale* is further removed from the *f. alisphenoidale* than in the coyote, and is exterior to and a little behind the *f. carotideum*.

The nasal bones extend to above the middles of the orbits, and contract gradually to their apex. Their combined anterior border is a regular concave; and the lateral angles at this point are produced outwards and forwards. The posterior apex of the premaxillary bone is separated from the anterior apex of the frontal by a short space. The maxillo-malar suture is deeply notched in front below, and it extends upwards to above the infraorbital foramen. A very narrow surface of

the lachrymal is exposed on the external surface. The pterygoid bone is distinct, and is nearly equally bounded by the sphenoid and palatine on the outer side. The inferior suture of the orbito-sphenoid runs in a groove, which is deepest anteriorly.

The crowns of all the incisor teeth are narrow or compressed, and, though slightly worn, present no indication of notch. As usual, the external ones are much the largest in antero-posterior diameter. The canines have robust fangs and rapidly tapering crowns, which are but little compressed. The first superior premolar is one-rooted, and the crown is simple. The crown of the second is without posterior heel and tubercle, while the third possesses both. The sectorial is relatively short, less so than in *C. latrans*; the blades are low and obtuse as compared with recent species, and the notch separating them is quite open; the anterior external heel is small; and there is no anterior external tubercle. The first tubercular molar is large, and the crown is narrower than that of *C. latrans*; it has an obtuse external cingulum, two external conical cusps, a V-shaped median ridge, and a wide internal cingulum; this crown differs from the corresponding one of *C. latrans* in having conical instead of compressed external cusps, and a simple V-shaped crest within instead of two adjacent cusps. The second tubercular is smaller than in *C. latrans*, and its tubercles are less distinct. There are two outer tubercles, a V-shaped ridge, and an inner cingulum, all very obscure. The enamel of all these teeth is smooth.

### Measurements of Cranium.

	metre.
Length along base of skull, including incisive border and occipital condyle .....	·160
Length of skull to palatal notch .....	·075
Length of skull to posterior border of pterygoid bone .....	·102
Length to front of orbit axially .....	·046
Width between zygomas (greatest) .....	·094
Width between orbits (least) .....	·036
Width at postorbital constriction .....	·021
Width between bases of canines .....	·017
Width between bases of second tuberculars .....	·027
Width between otic bullæ .....	·009
Width between apices of paroccipitals .....	·042
Width of foramen magnum .....	·017
Width of occiput above .....	·032

Six well-preserved crania of this species are embraced in the collection; and the mandible remains attached to some of them. One of these exhibits the following characters:—There is a well-developed marginal lobe of the posterior cutting-edge

of the third and fourth premolars, as well as a low posterior heel and a rudiment of an anterior one. The heel of the sectorial is shorter than the remaining part of the tooth, and rises to a cutting-edge a little external to the middle line; there is a small tubercle at its interior base. The anterior blade-cusp of the sectorial is much lower than the median, which is conical; the two diverge, diminishing the shear-like character and action of the tooth; the internal cusp is well developed. The first tubercular is of moderate size, and is a longitudinal oval in outline; the crown supports two low tubercles anterior to the middle, of which the external is the larger. The last molar has a single compressed root; and the crown is a longitudinal oval in outline: its position is on the ascending base of the coronoid ramus; so that the crown is slightly oblique. The masseteric fossa is profound and well defined; its anterior termination is below the middle of the second tubercular tooth. The horizontal ramus is not robust, but is compressed and rather deep.

*Measurements of Mandible.*

	metre.
Length along bases of posterior five molars .....	·049
Length of base of fourth premolar .....	·011
Elevation of crown.....	·008
Length of base of sectorial .....	·018
Elevation of crown of sectorial.....	·012
Length of base of first tubercular .....	·0075
Width of base of first tubercular .....	·005
Length of base of second tubercular .....	·005

While the characters of this dog do not separate it widely from the genus *Canis*, many of them are quite different from those presented by the recent species of the genus with which I am acquainted. Thus the union of the foramina speno-orbitale, rotundum, and alisphenoidale anterius, the anterior position of the orbits, and the postorbital constriction are not seen in the wolf, domestic dog, coyote, jackal, or the North-American and European foxes. The size of the brain was evidently less than in those species, and the sectorial teeth quite inferior in the efficiency of their blades. These characters may be considered in connexion with the low geological position of the beds in which the species occurs.

From the Truckee beds of the White-River formation in Oregon.

CANIS, Linn.

The names proposed by Smith, Gray, and others, and which must be regarded as synonyms of *Canis*, are *Lupus*, *Dieba*, *Simenia*, *Chrysocyon*, and *Lycalopex*. Many of the

species referred to by European palæontologists under the name of *Cynodictis*, Pomel, appear to me to be undistinguishable from *Canis*. Through the great kindness of M. Fillol, I possess specimens of the jaws of several of these species. A mandible with nearly complete dentition of the *Cynodon velaunum* of Aymard agrees very nearly with the jaws of some of the smaller species from the American White-River beds which I have referred to *Canis*. *Helocyon*, Aym., may be distinct, but may not belong to the Canidæ.

The dentition of many of the recent species of *Canis* differs in very slight characters. The following may be detected in an examination of the superior molars of the three larger species most accessible in the United States :—

Last superior tubercular short wide; inner cingulum and crest nearly confounded.

Inner crest of tub. M. 1 composed of two low tubercles. *C. familiaris*.

Vars. *molossus*, *terrarius*, *graius*.

Last superior tubercular narrower, transverse; inner cingulum very distinct.

Inner crest of tub. M. 1 a ridge higher anteriorly . . . . . *C. lupus*.

Inner crest of tub. M. 1 with two sharp cusps . . . . . *C. latrans*.

It is worthy of note that the wide oval form of the second superior molar of the *Canis familiaris* exists equally in the extreme races or species, the greyhound and bulldog, as I observed by examination of several crania of each; this has also been shown by De Blainville; it is also seen in the terrier and in various other races: but in some St.-Bernard crania in the Museum of the Academy of Natural Sciences this tooth is more elongate, and in some of the specimens of *Canis lupus* from Europe its form is quite the same; so this character, as might have been anticipated, is not of universal application. Another character is seen in the crania of three specimens which are supposed to belong to *Canis terrarius*. The superior border of the foramen magnum is interrupted by a deep vertical excavation. This is not seen in the St. Bernard, the bulldog, greyhound, and other races, nor in any of the feral or extinct species of the genus examined. It appears to be associated with an increased size of the brain, and to be an adaptation to the vermis of the cerebellum. The expansion of the brain is also indicated by the protuberance of the frontal region, and the wide separation of the temporal fossæ by a smooth space on each side of the sagittal suture. This space does not exist in the greyhound; but a narrow one is found in the bulldog. These characters are important on various grounds, but are here mentioned in reference to the species of *Synagodus* and *Dysodus*, where they reappear.



The absence of the second inferior tubercular molar is also not uncommon in the "black-and-tan" terrier.

I do not see the propriety of retaining the generic name *Nyctereutes*, Temm., for the *Canis procyoninus* of Japan. The peculiarity it presents in the form of the first superior tubercular molar, the only one\* on which the genus reposes, I would regard as specific only.

#### VULPES.

I would, with Gill, refer to this genus the species mentioned by Gray and others under the generic names *Pseudalopex*, *Fennecus*, and *Leucocyon*. The form of the postfrontal process certainly does not furnish generic characters.

#### UROCYON, Baird.

The peculiar cranial ridges, in which this genus resembles one of the extinct genera of Mustelidæ, appear to me to be the character which warrants its separation from *Vulpes*.

#### ENHYDROCYON, Cope.

(Bulletin U.S. Geological Survey Terr. v. 56, 1879.)

Two species from the White-River beds of Oregon are known.

#### TOMARCTUS, Cope.

(Ann. Report U.S. Geol. Surv. Terrs. 1873 (74), p. 519;  
Paleontological Bulletin, 1873, Aug. 20.)

One species known from the Loup-Fork beds of Colorado. It is uncertain whether this genus has two or three premolars. Should it have three, it must be compared with the *Brachycyon* of Filhol. But the inferior sectorial tooth of that genus is as yet unknown.

#### SPEOTHUS, Lund, 1843. *Cuon*, Hodgs.

One extinct species of this genus was found by Lund in caves in Brazil. Another species, *Speothus primævus*, is now living in the Himalaya region. Several other recent species have been named, but they are said by some authors to be varieties only of the *S. primævus*.

#### SYNAGODUS, Cope, gen. nov.

The characters of this genus have been pointed out in the analytical key. They are evidently as important as those

\* According to the figures of Temminck and Schlegel.

which define the divisions which are regarded as genera by naturalists. It is not unlikely that the typical species has been heretofore estimated as a variety of *Canis familiaris*; but it exhibits two trenchant generic dental characters not found in *Canis*, and three unique specific characters in the teeth, besides two characters of the cranium found in but one or two of the subspecies of *Canis familiaris*.

The generic characters alluded to are (1) the absence of the second inferior tubercular molar, and (2) the absence of the internal tubercle of the inferior sectorial. The absence of the second inferior tubercular is evidently not one of those abnormal cases which occur in various species of *Canis* from time to time; for the first tubercular molar is smaller than in any known species of *Canis*, and has but one root, a character which some persons might regard as being the third of the generic category. The premolars are 4—4, and of the usual form; the first in both jaws is one-rooted.

It is uncertain whether any species of this genus exists in the wild state. Should such not be the case, we can only predicate the former existence of such a one entirely different from the *Canis familiaris*, and which has given origin to the existing one below described.

*Synagodus mansuetus*, sp. nov.

Two crania represent this species in the Museum of the Academy of Natural Sciences. They agree in all essential particulars. The incisor and premolar teeth present no peculiarities (the latter are without marginal lobes); and the superior sectorial is normal. The first tubercular has less transverse extent than in the *Canidæ* generally; and its median crest and inner cingulum are confounded, a character which I have not found in any of the other species accessible. Thus the crown of this tooth consists of an external pair of tubercles, a basin, and a stout inner marginal prominence. The second tuberculars are abnormally small in one specimen; and in the other they are wanting. The 3rd and 4th inferior premolars have marginal posterior lobes. The inferior sectorial, as already stated, has no inner tubercle; its heel is peculiar in the great elevation and submedian position of one of its borders, approaching *Temnocyon* in this respect; the other edge, however, is distinct, thus forming an unsymmetrical basin. The first inferior tubercular is small, one-rooted; and the crown is subround, and with a single median tubercle. In the other usual species of *Canis*, *Vulpes*, and of many other genera of the family this tooth is elongate, two-rooted, and supports at least two tubercles.

In general form the crania resemble those of some of the terriers. The brain-case is full and convex, the orbits are lateral, and the muzzle is moderately elongate and narrowed. The osseous surfaces are generally smooth; and there is no indication of the ridge bounding the temporal fossa above. There is a deep sinus of the superior border of the foramen magnum, a character above noted as occurring in a subspecies included under *Canis familiaris*.

I have been unable to ascertain whether the species now described is one of the forms which have been referred to *Canis familiaris* under a subspecific name. One of the specimens was presented to the Academy many years ago by Dr. Paul Goddard, under the name of lap-dog. The form of the head shows that it is not one of the forms of *Canis extrarius hispanicus* (of Fitzinger's work on Dogs), which are represented by the King Charles spaniel and other lap-dogs. As I can find nothing concerning it in the books, I give it a provisional specific name.

The origin of the characters of this genus is doubtless to be traced to prehistoric time, if not to an early Tertiary geologic age. Perhaps some of the species-characters are of later origin, such as the obliteration of the superior-border ridges of the temporal fossæ and the large sinus of the foramen magnum. These characters, seen in a lesser degree in a domesticated true *Canis*, as above mentioned, are evidently an adaptation to an enlarged brain—the one to the increased cerebral hemispheres, the other to the protuberant vermis of the cerebellum. Whether these characters are due to a prolonged domestication, and abnormal nutrition within human habitations, remains to be ascertained. I remark here that two crania of dogs found mummied in Egypt by Mr. Gliddon, and now in the Museum of the Academy, present all the normal details of structure of *Canis familiaris*.

The reduction in the number of teeth has been carried further, and is probably of more modern origin, in the new genus to be described below.

#### DYSODUS, gen. nov.

The characters of this genus, already indicated in the analytical Table, are as follows:—I.  $\frac{3}{3}$ ; C.  $\frac{1}{1}$ ; Pm.  $\frac{2}{2}$ ; M.  $\frac{2}{1}$ ; inferior sectorial without internal tubercle. The incisive formula might with propriety read  $\frac{0}{0}$ , since these teeth are shed at an early age; and for the same reason the tuberculars might be stated  $\frac{1}{1}$ , since the last one of the upper jaw is equally evanescent. I, however, give the genus the benefit of the possible future discovery of species in which the teeth in

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question may not be so early caducous, and rely on the restricted diagnosis. It is thus apparent that the genus *Dysodus* is distinguished from *Synagodus* by the absence of two premolars from each jaw. While the genera agree in other respects, their typical species are very different.

This genus probably diverged from that now represented by *Synagodus* at a comparatively late period. Although it exhibits a greater degree of dental reduction than that form, I admit that the possibility of its having come off from *Canis* rather than from *Synagodus* is worthy of consideration. This is suggested by the fact that the remaining (first) tubercular molar of the inferior series is, in *D. pravus*, more like that of the species of *Canis* in all respects—among others, in having two roots.

In *D. pravus* the superior third premolar is sometimes shed, like the incisors, leaving the formula, I.  $\frac{0}{0}$ ; C.  $\frac{1}{1}$ ; Pm.  $\frac{1}{2}$ ; M.  $\frac{1}{2}$ . I have excluded this character from the generic diagnosis, as in the case of the incisor and superior tubercular teeth, because they are at the present time *unstable*; that is, the parts in question are in process of metamorphosis. When characters are thus variable, they cannot be used as the bases of natural divisions; but when they are *stable* we are compelled to recognize them. The characters which I have included in the diagnoses of *Synagodus* and *Dysodus* I have thought to be of this character; and I am by no means sure that the absence of the superior incisor teeth should not be placed in the same category. But none of these characters, whether stable or unstable, can be regarded as monstrosities, such as multiplied digits, fissured palate, &c. They are, on the contrary, in the direct line of numerical succession of parts already represented by the genera of Canidæ and of all digitigrade Carnivora. This, as already stated, consists in the reduction in the number of the teeth and their tubercles, forming a series which, commencing with the generalized extinct type *Amphicyon*, approaches more and more nearly to the Felidæ. In the inferior sectorial, the genus *Dysodus* approaches nearest of all Canidæ to some of the earliest genera of cats, as *Hoplophoneus* (although easily distinguishable); while in the reduction of its premolars it approaches the modern forms of that family. In the early shedding of the incisors it reaches a condition not found in any Carnivora, but one which marks the extreme of development of the ungulate mammals in various lines, *e. g.* Ruminantia, Omnivora, and Amblypoda.

*Dysodus pravus*, sp. nov.

This species, which is known as the Japanese sleeve-dog,

is represented in the Museum of the Academy of Natural Sciences by a complete skeleton, with the crania of two other individuals. These all belong to adult animals of a single litter, which were born in the United States. The parents of these dogs were procured in Japan by Dr. W. S. W. Ruschenberger, U. S. N., now President of the Academy. Other specimens have been brought to the United States by officers of the navy. Dr. J. E. Gray figures a skull of the same dog in the 'Proceedings of the Zoological Society of London' for 1867.

The crania in the Academy's collection are almost exactly alike, and resemble the one figured by Dr. Gray, so far as can be discovered. But Dr. Gray's specimen was probably young, as the incisor teeth and a premolar in each jaw have not yet been shed, and there are some cranial fontanelles still remaining.

The characters displayed by the skulls are as follows:—The muzzle is excessively abbreviated, and the forehead very convex. The brain-case is almost globular, and the zygomata proportionally prominent. The superior marginal ridge of the temporal fossa is prominent; and those of opposite sides are well separated as far as the posterior parietal region. Here they approach each other abruptly, forming a wide sagittal crest. The muscular insertions and other osseous ridges of the supra-, ex-, and basioccipital regions are strongly marked. The postorbital process is prominent and decurved. The vertical sinus of the superior border of the foramen magnum is deeply excavated. The external surface of the brain-case and of the zygomata is minutely rugose.

There are no lobes of the posterior border of the anterior superior premolars, while they are present on the two inferior premolars. The superior sectorial is normal, while the first superior tubercular is like that of *Synagodus mansuetus*, without distinct median crest or tubercle. The heel of the inferior sectorial is also like that of the species just mentioned; one border is much more elevated than the other, and forms a cutting-edge. The inferior tubercular is small, is longitudinally oval, and supports two low tubercles. This is one of the most important points of difference between this species and *S. mansuetus*. In none of the specimens is there any trace of the second tubercular.

The skeleton is that of a dog of the size of a rather small black-and-tan terrier.

Dr. Ruschenberger states that the incisor teeth of the dogs were shed at the age of about six months. He also informs me that they did not breed after coming to this country. Dr.

Gray states that these dogs are fed largely on vegetable food in Japan, and have an artificial existence in various respects. They are, according to Dr. Ruschenberger, uncommon and expensive in Japan.

I have been unable to discover that any name, whether varietal or specific, has been given to this dog.

### ICTICYON, Lund.

One existing and one extinct species have been found in Brazil—the latter in the caves. I describe a species from Oregon which I cannot separate from them generically.

#### *Icticyon crassivultus*, sp. nov.

This dog is so far represented by a skull which, while it lacks the parietal and occipital regions, is otherwise nearly complete, having both mandibular rami. The dental formula is, I.  $\frac{3}{3}$ ; C.  $\frac{1}{1}$ ; Pm.  $\frac{4}{4}$ ; M.  $\frac{1}{2}$ . The single superior tubercular molar is similar in general to that of other Canidæ. The inferior sectorial has an internal cusp and posterior heel, the latter with a low cutting-edge on one side. Inferior tubercular well developed.

The dental formula of this animal is that of *Icticyon*, Lund, of which a species has been found in the cave-deposit of Brazil, and another still lives in that region.

*Char. spec.* The snout is short and robust; and the profile from the parietal region is straight and descending. The premaxillary border projects but little beyond the line of the extremity of the nasal bones. The muzzle is slightly contracted in front of the orbit and above the fundus of the canine alveoli. The latter cause a swelling on the side. The infraorbital region is somewhat cracked, but appears to have been nearly flat mesially; laterally it descends steeply to the supraorbital border. The orbit is not large; and the zygomatic fossa is short. The nasal bones are narrowed posteriorly, a little contracted mesially, and expanded anteriorly, their lateral portions being produced along the premaxillaries. Their combined nasal border is concave, and is without the notches of some forms. The foramen infraorbitale exterius is of medium size, and issues above the interval between the sectorial tooth and the one in advance of it. The mandibular ramus is quite robust, and its inferior border is gently convex. The masseteric fossa is bounded by elevated borders, especially inferiorly; and the angular hook is prominent and robust. The condyle is situated on the horizontal line of the tubercular molar, or a little above the others, and has a wide transverse

extent, chiefly inwards. The coronoid process is high and wide, and is turned backwards so as to vertically overhang the condyle. Its anterior border is wide below, and becomes horizontal above.

The teeth partake of the robust character of the skull, with the exception of the incisors. Of these the crowns of the external are long and narrow and the median small in the premaxillaries, while those of the lower jaw are all small. The canines in both jaws are quite robust; and those of the lower jaw are rather abruptly recurved. The first premolar is small, and has a simple crown and single root. The crowns of the other premolars are wide at the base, and form each a simple cone, with a short posterior basal heel. The upper sectorial is relatively not long, but is robust, and with thick blades. The internal heel is well developed, as in *Canis*, while a cingulum represents an anterior lobe. The tubercular molar is narrower in fore-and-aft diameter than in *Temnocyon coryphæus* or *Canis latrans*, although it presents the same details: these are a wide obtuse external cingulum, two external tubercles, a median obtuse tubercle, and a wide internal cingulum. The premolars of the lower jaw are similar to those of the maxillary bone. The inferior sectorial is quite robust, and the internal cusp is well developed; the heel is shorter than the blades of the crown, and is wide and without tubercles in its somewhat worn condition; its external border rises to an edge. The tubercular is wider than the corresponding tooth in the contemporary species of Canidæ, although not so wide as long; its crown rises in two low tubercles which stand transversely near the middle.

#### Measurements.

	metre.
Length of skull to orbit (axial) .....	·049
Depth of skull to orbit (axial) .....	·042
Interorbital width .....	·040
Width of nares .....	·017
Length of superior molar series .....	·038
Length of bases of three premolars .....	·019
Length of base of sectorial .....	·013
Width of sectorial in front .....	·009
Width of first tubercular, antero-posterior.....	·006
Width of first tubercular, transverse .....	·014
Length of mandible to angle .....	·093
Elevation at coronoid.....	·051
Elevation at sectorial .....	·020
Length of inferior molar series.....	·045
Length of inferior sectorial .....	·014
Length of heel of inferior sectorial .....	·003
Length of inferior tubercular .....	·006
Width of inferior tubercular.....	·005

Van der Hoeven has given\* descriptions and figures of the skull and dentition of the *Icticyon venaticus* of Lund, of Brazil. From these it appears that the present species differs from the latter in the greater development of the inner part of the tubercular molar of the superior series; in *I. venaticus* this part is much reduced. The tubercular molar of the lower jaw is also much smaller in the living species, the angular and coronoid processes less developed, and the condyle less extended transversely. The cranium of the *I. crassivultus* is much more robust, but not much longer than that of *I. venaticus*.

Discovered by J. L. Wortman in the Truckee beds of the White-River Tertiary of the John-Day River region of Oregon.

#### GENERAL OBSERVATIONS.

In both Canidæ and Felidæ the reduction of the dental series is connected with a contraction of the facial part of the skull, either posteriorly or anteriorly. *Enhydrocyon* is an example of anterior abbreviation and *Icticyon* of posterior contraction among Canidæ, while *Smilodon* and *Lynx* exhibit the anterior reduction in Felidæ. I have already pointed out that this reduction is accompanied by a corresponding increase in the size of the sectorial teeth. But the reduction in the number of teeth in geologic time has not been confined to the Carnivora, but belongs to the Ungulates and Primates as well. The small number of teeth is generally associated with high specialization among Mammalia generally. The genera *Synagodus* and *Dysodus* are the most specialized of the Canidæ.

I may here refer to the frequently observed reduced dentition of man. Darwin first pointed out the significance of the absence of the third molars from the standpoint of evolution, citing American cases; and I have observed the similar bearing of the absence of the external superior incisors†. These reductions are very frequent in the United States, and probably elsewhere among civilized nations; but statistics on this point are yet wanting. My friend Dr. C. N. Pierce, an experienced and scientific dentist of this city, informs me that he knows of twenty-eight families in which the external superior incisors are absent; to these, four families may be added which have fallen under my own observation: that the absence of one or both pairs of the third molars is still more common, is confirmed by Dr. Pierce's experience.

\* "Over het Geslacht *Icticyon*," Wis. en natuurk. Verh. der Koninkl. Akademie, Amsterdam, Deel iii.

† Proceedings American Philosophical Society, 1871, p. 234.



It is evident that we have here characters which, if stable, would indicate two or three genera of Hominidæ additional to *Homo*. They are unstable at present; that is, they are not yet invariably found in any race or species of man, or, in other words, are not so associated with other physical characters as to form a correlated index of them. But experience in palæontology and zoology renders it almost certain that these dental characters will at some future time assume this degree of importance by becoming stable. This is already indicated by the fact of their being constant in families at the present time.

What races will be thus distinguished generically it is not easy to indicate; but all those with prognathous crania may be safely excluded. It is improbable that Mongolian races will early participate in such a modification, as they have a tendency to prognathism and a generally strong dental development.

Since the reduction in the number of teeth is intimately connected with orthognathism, it is easy to suppose that it is primarily due to the diminished space allowed by the contracted maxillary arcade. This contraction is doubtless due to a deficiency of building-material, consequent on a transfer of force to some other part of the structure during the period of growth. This transfer may be to the superior part of the cranium, which is extended to contain an enlarged brain. As the loss of a tooth from each side has so far been sufficient to accommodate the dentition to the space which it is to occupy, it is not likely that the absence of both I. 2 and M. III. will become established. The reduction in the inferior series is less; and I do not know of any example of the absence of the external incisors of the lower jaw. The loss of the third inferior molars is, on the other hand, very common. It then may be reasonably maintained that two genera of Hominidæ will be at some future day added to *Homo*—that the latter will include the inferior races of men, and the former the superior—that, although in specific characters there may be a want of greater constancy in the species of the new genera as compared with each other than as compared with the primitive and true *Homo*, they will present cases of what is elsewhere known in zoology, that the same or nearly the same specific characters may be found in different genera. Under such circumstances the form referred to a new genus becomes at the same time a distinct species. The genera of Hominidæ will then, if the characters become constant, be as follows:—

I. $\frac{2}{2}$ ; C. $\frac{1}{1}$ ; Pm. $\frac{2}{2}$ ; M. $\frac{3}{3}$ .....	<i>Homo</i> .
I. $\frac{1}{1}$ ; C. $\frac{1}{1}$ ; Pm. $\frac{2}{2}$ ; M. $\frac{3}{3}$ .....	<i>Metanthropos</i> .
I. $\frac{2}{2}$ ; C. $\frac{1}{1}$ ; Pm. $\frac{2}{2}$ ; M. $\frac{2}{2}$ .....	<i>Epanthropos</i> .

IX.—On the Squillidæ. By EDWARD J. MIERS, F.L.S., F.Z.S., Assistant in the Zoological Department, British Museum.

[Continued from p. 30.]

### PSEUDOSQUILLA.

*Squilla trapues*, M.-Edwards, Hist. Nat. Cr. ii. p. 525 (1837).

*Squilla* (sect. iii.) *parallela*, De Haan, Faun. Japon. Cr. p. 221 (1849).

*Pseudosquilla*, Guérin (ined.) \*, Dana, U.S. Expl. Exp. xiii. Cr. i. p. 615 (1852).

Carapace not longitudinally costate; cervical suture faintly defined or obsolete posteriorly. Rostral plate reaching to and covering the base of the eye-peduncles. Four posterior thoracic segments not covered by the carapace. The exposed thoracic and postabdominal segments are compactly articulated; and the latter are smooth, not longitudinally costate; the terminal segment well developed, and bearing at its distal end two mobile spines. Dactylus of the raptorial limbs not dilated at base, unarmed or with few spines on its inner margin. The appendages of the three posterior thoracic limbs are slender and styliform.

\* *Rostrum without a median spine. Antennules usually small and slender. Basal prolongation of the uropoda ending in two spines.*

### *Pseudosquilla ciliata*. (Pl. III. figs. 7, 8.)

? *Squilla ciliata*, Fabr. Ent. Syst. ii. p. 512 (1793), Suppl. p. 417 (1798); Owen, Zool. Voy. Blossom, p. 90, pl. xxvii. fig. 5 (1839); White, List Crust. Brit. Mus. p. 84 (1847).

*Squilla stylifera*, Lam. Hist. An. sans Vert. v. p. 189 (1818); Latreille, Encycl. Méth. x. p. 472 (1825); Guérin, Icon. Crust. R. A. pl. xxiv. fig. 1; M.-Edw. Hist. Nat. Crust. ii. p. 526 (1837); Gibbes, Proc. Amer. Assoc. p. 200 (1850); Hoffmann, Recherches Faune Madagascar, Cr. p. 43 (1874).

*Pseudosquilla stylifera*, Dana, U.S. Expl. Exp. xiii. Cr. i. p. 622, pl. xli. fig. 4 (1852).

? *Pseudosquilla stylifera*, v. Martens, Archiv f. Naturg. xxxviii. p. 146 (1872).

Carapace smooth, with the longitudinal sutures straight and continuous from the anterior to the posterior margin, but without the transverse cervical suture; its posterior margin straight, with the antero-lateral and postero-lateral angles rounded and not produced. Rostral plate nearly of a trans-

\* Eydoux and Souleyet (Voy. Bonite, Zool. i. p. 263) say that this genus was established by Guérin to include, besides *P. ciliata* and *P. oculata*, two new species, *P. cylindrica* and *leptodactyla*, Guérin; but I cannot discover any published descriptions by him.

versely-oval shape, smooth above. Exposed thoracic segments not produced laterally; the first segment very narrow and acute on the sides, the second broader and laterally subtruncated, the third more rounded laterally. The fifth post-abdominal segment bears a small tooth or spine at its postero-lateral angle; the sixth segment is armed with six spines, the second on each side being placed nearer to the anterior margin. The terminal segment is armed with two longitudinal carinæ on each side of the median keel (the inner of the two being much less strongly marked), and there is a third carina on each side close to the lateral margin; there are six lateral spines, the two mobile and submedian spines being the longest. The dactyli of the raptorial limbs are armed with three slender spines (including the terminal spine, which is longest). The terminal spines of the basal prolongation of the uropoda are nearly equal; and the inner spine is not toothed on its outer margin. Length nearly 3 inches.

*Hab.* Indo-Pacific Region.

The series in the Museum collection includes a female from the Indian Ocean, labelled *P. ciliata* by Leach, and another without locality (*Old Collection*), a male and female from the Philippine Islands (*H. Cuming, Esq.*), two males from the Sooloo Sea (*A. Adams, Esq.*), a female from Australia (*H.M.S. 'Rattlesnake,' Macgillivray*), a female from Ovalau in the Fiji Islands (*H.M.S. 'Herald'*), two males from the Sandwich Islands, Honolulu (*Lieut. Strickland*), a female from Florida Island in the Solomon group (*J. Brencley, Esq.*), and one from the Seychelles (*Dr. E. P. Wright*).

It is recorded from the Mauritius and Red Sea; Von Martens also records it from Cuba; hence it would appear that this species, like *Gonodactylus chiragra*, is not confined in its range to the Indo-Pacific Region.

The male, according to Mr. G. Clark, who had the opportunity of observing this animal in the living state, is of a beautiful bluish-green colour, with the jaw-feet, swimmerets, and branchiæ, as well as the antennæ and fimbriæ which border the different organs, of a cherry-red. The female is clouded with brown and grey, presenting much the appearance of tortoise-shell; and the red about her is much less vivid than in the male (*P. Z. S. 1869, p. 3*).

*Squilla quadrispinosa*, Eyd. & Souleyet (*Voy. Bonite, Zool. i. Cr. p. 262, pl. v. fig. 1*), from the Sandwich Islands, closely resembles this species, but is described as having the left-hand mobile spine of the terminal segment bifid. Can this be an accidental malformation?

*Pseudosquilla oculata.* (Pl. III. figs. 3, 4.)

*Squilla oculata*, Brullé, in Webb and Berthelot, Iles Canaries, Zool. Crust. p. 18, fig. 3 (1836-44).

Body smooth. Carapace rounded at its antero-lateral and postero-lateral angles. Rostral plate transverse, smooth and flat above, ending in a very small median spinule. Lateral processes of the first exposed thoracic segment very short and subacute, those of the second and third segments larger and truncated. First to fifth postabdominal segments smooth and unarmed, the postero-lateral angles of the fifth segment only ending in a small spinule. Sixth segment armed with six spines, which are produced considerably beyond its posterior margin, with the exception of the spines next the submedian ones, which are short. Last segment with the median carina ending in a spine, and with four other carinulæ on each side of it (including that of the lateral margin); marginal spines six. Antennules and antennæ very small and slender. Raptorial limbs with the penultimate joint slender, elongated, and slightly widening at its distal end; dactyli three-spined. Uropoda with the basal prolongation ending in two spines, of which the outer is the longer. Length of the largest individual in the Museum collection (a female)  $3\frac{1}{4}$  inches.

*Hab.* Canaries (*Webb and Berthelot*); Madeira (*Coll. Brit. Mus., Rev. R. Boog Watson*).

Besides the small female example from Madeira, there are two females without locality in the Museum collection.

This species is described in MM. Webb and Berthelot's work as being of a green colour, with numerous yellow rounded spots; there is a large round green spot on each side, bordered with a yellow ring; penultimate joint of raptorial limbs bordered with green and yellow; dactyli rose-coloured.

*Pseudosquilla monodactyla.* (Pl. III. figs. 1, 2.)

*Squilla monodactyla*, A. M.-Edw. Bull. Soc. Philom. Paris (1878).

In the specimen I refer to this species the carapace is smooth, rounded at its antero-lateral and postero-lateral angles, and not ocellated. Rostrum flattened, almost subtriangulate, with the sides straight and convergent to the apex, which is acute. Fourth to seventh thoracic segments with the lateral processes slightly rounded. Fifth postabdominal segment with a small spinule at its postero-lateral angles; sixth without carinæ, but armed with six small spines on its posterior margin, including those of the postero-

lateral angles. Terminal segment with an acute median longitudinal carina (but without lateral carinules or tubercles), with eight lateral marginal teeth, the one next the submedian teeth very small; the submedian teeth are tipped with a small mobile spine, and between them is a series of numerous, minute, closely placed and pectinately disposed spinules; between the lateral marginal teeth are also one or two spinules. The penultimate joint of the raptorial limbs is slender and armed with a small spine at its infero-distal angle; the dactylus is slender, arcuate, and without any spines on its inner margin. The appendages of the thoracic limbs are slender, not dilated. The uropoda are relatively large, and the spines of their basal prolongation are simple. Length rather more than 1 inch.

A small male was in a bottle with *Pseudosquilla oculata*; but the locality has unfortunately not been preserved. This very distinct species may be recognized at once by the form of the terminal postabdominal segment and the absence of spinules on the inner margins of the dactyli of the raptorial limbs—both characters which are mentioned by Prof. Alph. M.-Edwards in his brief description.

*Pseudosquilla ornata.* (Pl. III. figs. 5, 6.)

? *Pseudosquilla oculata*, Heller, Reise der Novara, Crust. p. 124 (1865), nec Brullé.

Under this name I separate two specimens in the Museum collection, one of which was formerly referred to *P. ciliata*. They are evidently closely allied to *P. oculata*, which they appear to represent in the Indo-Pacific Region; but they may be distinguished by the following characters:—The rostrum is not armed with a small median spinule; the longitudinal carinulæ of the terminal postabdominal segment are more flattened at base; and there are only three on each side of the median keel, the small carinula next that of the lateral margins being entirely absent. Length of the largest individual (a female) nearly 2 inches.

*Hab.* Philippine Islands (*coll. Brit. Mus., Cuming*).

Besides the female from the Philippine Islands there is a small male individual, from the collection of H.M.S. 'Herald,' in the Museum collection. As in *P. oculata*, there is on either side of the carapace a very distinct circular spot, bordered with a pale margin. This latter character, the truncated sides of the exposed thoracic segments, and the more transverse rostrum serve to distinguish both *P. oculata* and *P. ornata* from *P. ciliata*.

I believe the specimens from Tahiti, referred by Heller

(*l. c.*) to *P. oculata*, belong to this species, as the rostrum is described as "vorn abgerundet;" and of the terminal post-abdominal segment he observes, "gewahrt man auf der Oberfläche mehrere Längsleistchen, und zwar eine lange mittlere und zwei seitliche."

*Pseudosquilla styliфера.*

*Gonodactylus styliferus*, M.-Edwards, Hist. Nat. Crust. ii. p. 530, pl. xxvii. figs. 9-14 (1837); Gay, Hist. Chili, iii. p. 225, pl. ii. fig. 3 (1849).

Body smooth and somewhat depressed. Carapace somewhat narrowed anteriorly, without a spine at its antero-lateral angles, and rounded and rather laterally produced at its postero-lateral angles. Rostral plate smooth, longer than broad at base, and narrowing distally. First exposed thoracic segment very short and not laterally produced; second and third rounded on the sides; first to fifth segments of the postabdomen with the postero-lateral angles rounded and without spines; sixth segment armed with eight low obtuse crests, and without spines. Terminal segment with three longitudinal parallel obtuse crests, placed at some distance from one another, with the intervening spaces smooth, with eight large marginal teeth; between the submedian teeth of the posterior margin is a narrow fissure, and between these teeth and the next on each side a large rounded tubercle. The antennules are robust, but not so elongated as in the species of the next section. The dactyli of the raptorial limbs are smooth and unarmed and acute. The basal prolongation of the uropoda terminates in a large flattened lobe, which is denticulated on its inner margin and ends in a spine. Length of a male in the Museum collection about  $5\frac{1}{2}$  inches.

*Hab.* Chili.

A male individual is in the collection from Chili (*Bridges*), and a male and female from Coquimbo Bay (*Dr. Cunningham*).

This species evidently marks the transition from *Pseudosquilla* to *Gonodactylus*.

Near to this species perhaps is *Gonodactylus ensiger*, Owen (P. Z. S. 1832, p. 6), from Valparaiso, which is described as allied to *Gonodactylus chiragra*, but with the dactylus of the raptorial limbs not ventricose at base, acute on its inner margin, with the rostrum trispinose, the median spine obsolete. Length 6 inches.

*Pseudosquilla? empusa.*

*Squilla empusa*, De Haan, Faun. Japon. Crust. p. 224, pl. li. fig. 6 (1849), nec Say.

Body smooth, punctated. Carapace narrowed anteriorly, with the antero-lateral angles obtuse, the posterior margin rounded. Rostrum almost three times as broad as long, impressed in the middle, with the anterior margin broadly truncated. Thorax and postabdomen of the same form as in *P. ciliata* (*S. stylifera*, Lam.). Lateral processes of the thoracic segments with the margin rounded. Postabdomen convex, unarmed; sixth segment indistinctly six-costate, with the posterior margin unispinose on each side; seventh segment with the median keel produced, with a smaller keel on each side placed near to the median one, and another midway between the median keel and lateral margin; lateral margin arcuate before the middle, sinuate beyond the middle, with short flattened spines. Eyes scarcely broader than the middle of the peduncles. Antennules robust, with the peduncles shorter than the antennæ. Raptorial limbs with the penultimate joint narrower at each end, and with the dactyli and spines compressed. The distal prolongation of the base of the uropoda is represented as terminating in two unequal spines, of which the outer is slightly the longer.

*Hab.* Japanese seas.

De Haan founded this species on a unique example. He seems to have been unaware of Say having previously adopted the name of *empusa* for a species of *Squilla*. The above description is taken from his work.

\*\* Rostral plate terminating in a strong spine. Antennules very robust and elongated. Basal prolongation of the uropoda ending in a single terminal and two lateral spines.

*Pseudosquilla Lessonii.*

*Squilla Cerisii*, Guérin, Voy. Coquille, Crust. p. 40, pl. iv. fig. 1 (1830), *S. Lessonii* on plate.

*Squilla spinifrons*, Owen, Proc. Zool. Soc. p. 6 (1832).

*Squilla Lessonii*, M.-Edwards, Hist. Nat. Cr. ii. p. 527 (1837); White, List Crust. Brit. Mus. p. 84 (1847).

*Squilla monoceros*, M.-Edwards, Hist. Nat. Crust. ii. p. 526 (1837); Gay, Hist. Chile, Zool. iii. Cr. p. 224 (1849).

*Pseudosquilla Lessonii*, Dana, Cr. U.S. Expl. Exp. xiii. 1, p. 622 (1852).

? *Pseudosquilla marmorata*, Lockington, Proc. Cal. Acad. Sci. p. 33 (1877).

Carapace narrowed anteriorly, with the antero-lateral angles rather obtuse, and the postero-lateral lobes broadly rounded. Rostral plate terminating in a long spine and with the lateral

angles acute or even forming short spines. First thoracic segment not laterally produced; second and third segments not greatly produced, and rounded on the sides. First to fourth postabdominal segments with the postero-lateral angles rounded; in the fifth segment this angle terminates in a spinule; sixth segment armed, as usual, with six longitudinal spines; seventh with five longitudinal carinæ on each side of the median longitudinal keel, and with six marginal spines, between which are some smaller spines (no median spine on the posterior margin). Antennules very robust and greatly elongated. Dactyli of the raptorial limbs armed with a small tooth or tubercle near the base on the outer margin, and with two spines on the inner margin (besides the terminal spine). Distal prolongation of the base of the uropoda terminating in a strong spine, and with two other spines on its inner margin. Length nearly  $5\frac{1}{2}$  inches.

*Hab.* West coast of America.

In the British-Museum collection are two males from Chili (*Rev. Mr. Hennah*), another from the same locality (*purchased*), and another without locality from *Mr. Bell's* collection. Dana records this species from the Callao Roads.

*P. marmorata*, Lockington (*P. Cal. Ac. Sci.* p. 33, 1877), from San Diego, California, either belongs to this species or is very closely allied to it. The description, so far as it goes, applies very well to it.

### *Pseudosquilla Cerisii.*

*Squilla Cerisii*, Roux, *Crust. de la Méditerranée*, pl. v. (1828); M.-Edw. *Hist. Nat. Crust.* ii. p. 527 (1837); Lucas, *Anim. Artic. in Explor. Sci. Algérie*, i. p. 50 (1849); Heller, *Crust. südl. Europa*, p. 308 (1863); Haller, *Zool. Anzeiger*, p. 207 (1879).

*Squilla Broadbenti*, Cocco, *Giorn. di Scienze di Sicilia*, pl. iii. fig. 2 (1833).

The carapace is considerably narrowed anteriorly, and much wider posteriorly than the segments of the thorax; its antero-lateral angles are unarmed. The rostral plate terminates in a prominent spine, but is without lateral spines; the sixth postabdominal segment is armed with six spines; the terminal segment has seven marginal spines (there being a median spine), and is armed with five longitudinal carinæ on each side of the median keel. The antennules are robust, but less elongated than in *P. Lessonii*. The dactyli of the raptorial limbs are armed with two short spines besides the elongated curved terminal spine. The distal prolongation of the base of the uropoda is apparently slender, terminates in a spine, and is armed with two teeth or spines on its inner margin.



*Hab.* Mediterranean (Toulon, Corsica, Roux; Messina, Kessler; Sicily, Cocco; Algiers, Lucas; Morea, Guérin; Nice, Haller).

I have seen no specimens of this species; and the above description has been taken from the description and figure of Roux. According to that author, the general colour of the body is greenish or yellowish, the antennæ and hairs are rose-coloured, the posterior margin of all the postabdominal segments and the last two segments are brick-red.

It is evidently very nearly allied to *P. Lessonii*, but differs apparently in the absence of lateral spinules on the rostral plate, of the small tooth or tubercle at the base of the outer margin of the dactyli of the raptorial limbs, and in the existence of the median terminal spine of the last postabdominal segment.

### GONODACTYLUS.

*Gonodactylus*, Latr. Encycl. Méth. Hist. Nat. x. p. 473 (1825); Cr. in Cuv. Règne Anim. iv. p. 109 (1829); M.-Edw. Hist. Nat. Cr. ii. p. 528 (1837); De Haan, Faun. Japon. Cr. p. 220 (1849); Dana, Cr. U.S. Expl. Exp. xiii. p. 615 (1852).

In nearly all its characters this genus resembles *Pseudosquilla*; but the penultimate joint of the raptorial limbs is not armed with minute pectinately-disposed teeth as in that genus, and the dactylus is considerably dilated at base; the mobile spines at the distal end of the terminal postabdominal segment are very small or obsolete.

The *Gonodactylus setimanus* of De Kay (Zool. New-York Fauna, Cr. p. 34, pl. viii. fig. 2) does not belong to the Stomatopoda, but to the Thalassinidea, and is regarded by Gibbes as identical with *Callianassa major*, Say.

\* *Rostrum not ending in a spine.*

### *Gonodactylus scyllarus*.

*Squilla arenaria prona*, Seba, Thesaurus, iii. p. 5, pl. xx. fig. 3 (1758).

*Cancer scyllarus*, Linn. Syst. Nat. (ed. xii.) p. 1054 (1766).

*Squilla scyllarus*, Fabr. Ent. Syst. ii. p. 512 (1793); Suppl. p. 416 (1798).

*Cancer (Mantis) scyllarus*, Herbst, Nat. Krabben &c. ii. p. 99, pl. xxxiv. fig. 1 (1796).

*Squilla scyllarus*, Lam. Hist. Anim. sans Vert. v. p. 189 (1818).

*Gonodactylus scyllarus*, Latreille, Encycl. Méth. x. p. 472 (1825); M.-Edw. Hist. Nat. Crust. ii. p. 529 (1837); Atlas in Cuv. R. A. Crust. (ed. 3) pl. lv. fig. 2; White (part), List Cr. Brit. Mus. p. 85 (1847); Hoffmann, Recherches Faune Madagascar, Cr. p. 43 (1874).

Carapace smooth, nearly oblong, scarcely narrowing ante-

riorly, with the anterior and posterior margins straight, the antero-lateral and postero-lateral angles rounded. Rostrum smooth, transverse, and somewhat triangular in form, acute at its distal end. First exposed thoracic segment not produced on the side; second and third segments with the lateral processes rounded. Lateral margins of the first to fifth post-abdominal segments ridged; ridges ending in a small spine on the fourth and fifth segments. There is an oblique shallow depression on the sides of each of these segments, which in the fifth segment is margined externally by a distinct ridge; the sixth segment is armed with eight longitudinal ridges, which terminate usually in spinules, and with two smaller prominences near the base. Median crest of the terminal postabdominal segment much elevated, interrupted near the base, and ending in a spinule; on either side of it are three obtuse crests. The marginal teeth are greatly developed, flattened, ridged above, and terminate in spines, those of the two terminal teeth being mobile. The antennules and antennæ are nearly of equal size. The dactyli of the raptorial limbs are armed with a cutting-edge on their inner margins, and with two distant teeth besides the terminal spine. The distal prolongation of the base of the uropoda ends in two strong spines; and the series of spines on the outer margin of the penultimate joint of the outer ramus are flattened and considerably elongated. Length of an adult male about 6 inches.

*Hab.* Indo-Pacific Region.

It is remarkable that *all* the specimens of this widely distributed species in the Museum collection are males.

The series includes examples from the Mauritius (*General Hardwicke* and *Lady F. Cole*), Zanzibar (*Dr. Kirk*), Madagascar (*A. Newton, Esq.*), Seychelles (*Dr. E. P. Wright*), Samoa Islands (*Rev. S. J. Whitmee*), and two or three without particulars respecting locality.

### *Gonodactylus japonicus.*

*Gonodactylus Edwardsii*, Berthold, Abhandl. königl. Gesellsch. Wissenschaft. Göttingen, iii. p. 30, pl. iii. fig. 6 (1847).

*Gonodactylus japonicus*, De Haan, Faun. Japon., Crust. p. 225, pl. li. fig. 7 (1849).

This species is very nearly allied to *Gonodactylus scyllarus*, but may be distinguished by the following characters:—The rostrum is sinuated on the sides, and has the tip more obtuse and strongly incurved. The sides of the postabdominal segments are without the wide shallow impression of *G. scyllarus*. There is a distinct median carinula between the submedian keels of the sixth segment. There are from five to

seven small serratures or teeth on the inner margins of the dactyli of the raptorial limbs. Length about  $5\frac{2}{3}$  inches.

*Hab.* Japan (*De Haan*); Chinese seas (*Berthold*; *coll. Brit. Mus.*).

The two specimens in the Museum collection are males.

*Gonodactylus cultrifer.*

*Gonodactylus cultrifer*, White, Proc. Zool. Soc. p. 96, (*Annulosa*) pl. xvi. fig. 1 (1850).

Carapace smooth, with the antero-lateral and postero-lateral angles rounded and the posterior margin straight. The rostrum is quadrilateral, smooth, with the sides slightly convergent distally, and the anterior margin straight. The first thoracic segment is not produced on the sides; second and third with the lateral processes rounded. First to fifth post-abdominal segments smooth; there is a small spinule at the postero-lateral angles of the fifth segment; sixth segment armed with six longitudinal carinæ, which terminate in spines, another carina on each side is represented only by tubercles near the anterior margin of the segment; terminal segment with an elevated laminiform median crest, which in vertical height nearly equals the space between its base and the lateral margin; the upper margin of this crest is arcuate and terminates in a small spine; on either side of the median crest are two longitudinal carinæ; the spines of the lateral margins are not flattened and dilated. The basal portion of the dactyli of the raptorial limbs is not much thickened; the terminal portion is elongated and knife-shaped, and its inner margin is armed with two teeth. The outer spine of the basal prolongation of the uropoda is much longer than the inner; and the outer margin of the penultimate joint of the outer ramus is armed with nine flattened spines (not twelve as in *G. scyllarus*). Length nearly 4 inches.

*Hab.* China.

Two males are in the British-Museum collection. The integument is remarkably thin and membranous, and, in the dried state, is of a reddish-pink colour, paler in the middle line and in other places.

*Gonodactylus? Bradyi.*

*Squilla Bradyi*, A. Milne-Edwards, in Fonds de la Mer, (livr. ix.) p. 137, pl. xvii. fig. 11 (1869).

Carapace short and broad; rostral plate large, subquadri-lateral, with an excessively small median tooth. Segments of the postabdomen depressed, without longitudinal carinæ;

penultimate and terminal segments uniformly covered with numerous closely-placed slender spines, which are longest near the posterior margin. The eyes are scarcely dilated distally; the basal scales of the antennæ remarkably small; the raptorial limbs large, with the dactylus strongly dilated at base; it terminates in a slender arcuate spine, and is armed on the inner margin of the thickened portion with three spines placed near to one another. The uropoda are very small.

*Hab.* Bay of St. Vincent.

On account of the dilated dactylus of the raptorial limbs, it appears to me that this species must be placed in *Gonodactylus*; but it presents many affinities with *Lysiosquilla*. I have seen no specimens.

### *Gonodactylus Bleekerii.*

*Gonodactylus Bleekerii*, A. M.-Edwards, Nouv. Archiv. Mus. Hist. Nat. iv. p. 65, footnote (1868).

This species, according to M. A. Milne-Edwards, differs from *G. scyllarus* by the form of the rostrum, which, although enlarged at base, ends in a point, and by the existence of a lamellate median carina on the terminal postabdominal segment, which is much less elevated than in *G. cultrifer*.

*Hab.* Batavia (*Bleeker*). I have seen no specimens.

**\*\* Rostral plate terminating in a strong spine.**

### *Gonodactylus chiragra.*

*Mantis marina barbadensis*, Petiver, Pterigraph. Americ. pl. xx. fig. 10. *Squilla chiragra*, Fabr. Ent. Syst. ii. p. 513 (1793), Suppl. p. 417 (1798); Desmarest, Consid. Crust. p. 251, pl. xliii. (1825).

*Cancer (Mantis) chiragra*, Herbst, Naturg. Krabben &c. ii. p. 100, pl. xxxiv. fig. 2 (1796).

*Gonodactylus chiragra*, Latreille, Encycl. Méth. x. p. 473 (1825), Atlas, pl. cxxv. fig. 2; M.-Edw. Hist. Nat. Crust. ii. p. 528 (1837); Krauss, Südafrik. Crust. p. 60 (1843); White, List Crust. Brit. Mus. p. 84 (1847); Gibbes, Proc. Amer. Assoc. p. 201 (1850); Dana, Cr. U.S. Expl. Exp. xiii. 1, p. 623, pl. xli. fig. 5 (1852); Heller, Cr. südl. Europa, p. 309 (1863); Reise Novara, Crust. p. 126 (1865); Annesley, Proc. Zool. Soc. p. 338 (1866); S. I. Smith, Trans. Connect. Acad. ii. p. 41 (1869); v. Martens, Archiv f. Naturg. xxxviii. p. 147 (1872); idem in Van der Decken's Reise, Crust. p. 103 (1869); Hoffmann in Recherches faune Madagascar, Cr. p. 36 (1874); Miers, Phil. Trans. Roy. Soc. clxviii. p. 495 (1879).

Carapace smooth, nearly oblong, with the sides parallel, the antero-lateral and postero-lateral angles unarmed and rounded. Median spine of rostrum strong and acute; its lateral lobes but little prominent and rounded. First exposed thoracic segment not produced; the lateral process of the

second segment is somewhat rounded, that of the third segment subtruncate, and that of the fourth segment narrowed towards the lateral margin. Lateral margins of the first to fifth postabdominal segments carinated, but on none of the segments do the carinæ terminate in spines; the sixth segment is armed with six equidistant longitudinal prominences, which are narrowed posteriorly and terminate each in a spine; the upper surface of the terminal segment is armed with three elongated and convex prominences or tubercles, which do not terminate in spines, and with four triangular marginal teeth, of which the two posterior are very large, and tipped each with a small mobile spinule. The antennules and antennæ are small and slender; the dactyli of the raptorial limbs are without teeth on their inner margins, which are furnished with two rows of granules in their basal, and with a thin cutting-edge in their terminal half; the basal part of the dactylus is considerably thickened externally, and the styliform terminal portion is acute and usually sinuate. The distal prolongation of the base of the uropoda ends in the two rather short strong spines (the outer of which has no tooth on its inner margin). Length of a full-sized adult male nearly 4 inches.

This species is the commonest and most widely distributed of the genus. The series in the British-Museum collection includes specimens from the following localities:—Two males from the Red Sea, Dædalus Shoal (*Lieut.-Col. Playfair*); a female and young male from the Gulf of Suez (*R. M'Andrew, Esq.*); three males and a female from Zanzibar (*Dr. Kirk*); a fine adult male from Rodriguez Island (*Gulliver in Trans. of Venus Exped.*); a male from India (*Gardner*); three males from the Philippine Islands (*Cuming and H. J. Veitch*); a male and two females from Australia (*J. Macgillivray, Esq.*); a male from the N.E. coast of Australia, and a male and two females from Sir C. Hardy's Island (*J. B. Jukes, Esq.*); three males from Swan River (*Mr. Dring*); a male from North Australia (*Dr. J. R. Elsey*); two females from Port Essington (*Earl of Derby*); and a series of specimens from the Fiji Islands, including four females and several young specimens from Ovalau Reef, a male and two females from Bau, a female from Conway Reef (*H.M.S. 'Herald'*), besides several specimens collected in the same expedition without locality. The only specimens from localities not included in the Indo-Pacific Region are two from the Mediterranean that have long been in the collection (but no authority is recorded for this habitat), a small male brought from Panama by Mr. Bridges, and two males from a bottle containing Crustacea without definite

locality, but whose contents were evidently from the west American coast.

S. I. Smith had seen specimens he referred with doubt to this species from the Abrolhos (*Hartt*), Caravellas, province of Bahia (*Hartt*), Aspinwall (*F. H. Bradley*), Florida Keys (*Gibbes*), and Bermuda (*J. M. Jones*). Milne-Edwards and Heller record it from the Mediterranean, Krauss from Natal, Hilgendorf from Mozambique, and Hoffmann from Réunion.

*Gonodactylus graphurus*. (Pl. III. fig. 9.)

*Gonodactylus graphurus*, White, List Crust. Brit. Mus. p. 85 (1847); Miers, Ann. & Mag. Nat. Hist. (ser. 4) xvi. p. 344 (1875).

This specimen bears a considerable external resemblance to *G. chiragra*, but may be distinguished by the following characters. There is a small median keel between the innermost or submedian prominences of the penultimate postabdominal segment; there are seven closely-placed prominences on the upper surface of the terminal segment, the median being the largest, and the others becoming successively smaller; the median and submedian are usually armed with spines; there are moreover six marginal spines (the outermost of these are obsolete in *G. chiragra*); the outer of the two spines of the basal prolongation of the uropoda has a small tooth on its inner margin near its base; and these spines are longer and slenderer than in *G. chiragra*.

*Hab.* Indo-Pacific Region.

This species is scarcely less frequently and widely distributed than *G. chiragra*. Specimens are in the Museum collection from the following localities:—One male and two females from the Red Sea, El Tor (*Major M'Donald*); three males and six females from the Gulf of Suez (*R. M'Andrew, Esq.*); two males and a female from the Seychelles (*Dr. E. P. Wright*); four males and two females from Ceylon (*E. W. H. Holdsworth, Esq.*); a female from North Australia (*Dr. J. R. Elsey*); a male from Port Essington (*Mr. R. Tilston*); a female from Nicol Bay, N.W. Australia (*M. du Boulay*); a male from Port Curtis, one from Dunk Island, and a female from near Cumberland Island (*J. Macgillivray, Esq.*); two females from Sir-C.-Hardy Island (*J. B. Jukes, Esq.*); a male from Torres Straits (*Mrs. Campbell*); a female from the Sooloo sea (*H.M.S. 'Samarang'*); and two males from the Samoa Islands, Upolu (*Rev. S. J. Whitmee*); besides several specimens without locality collected in the voyage of *H.M.S. 'Herald.'*

*Gonodactylus Guérinii.*

*Gonodactylus Guérinii*, White, Proc. Zool. Soc. p. 43, pl. vii. (1861);  
Ann. & Mag. Nat. Hist. vii. p. 479 (1861).

This species is perhaps the most remarkable among the *Gonodactyli*, on account of the armature of the penultimate and terminal postabdominal segments. In most of its characters, however, it nearly resembles *G. chiragra* and *G. graphurus*. The antero-lateral lobes of the rostrum are not, as in those species, rounded, but produced into long spines, which nearly equal in length the median rostral spine. The fifth postabdominal segment is smooth at base and armed in its posterior half with about six transverse rows of numerous short spines, which increase in length as they approach the posterior margin of the segment; sixth segment armed with numerous (about fifty) strong spines, each somewhat blunt and tipped with a short bristle; these spines are smaller and more crowded towards the lateral margins of the segment; terminal segment armed on its upper surface with twenty-two long outstanding spines, and toward the lateral margins with two series of numerous closely-placed similar but shorter spines, all tipped with a bristle; these series converge along the outer margin and meet at the extremity of the two outer long spines of the four which arm the posterior margin of the terminal segment; these spines are of equal length, and the two inner, like the outer, are armed along their margins with smaller spines pectinately disposed. The styliform portion of the dactylus of the raptorial limbs is very long and slender; its inner margin is not armed with teeth or spines, but is very minutely pectinated. The outer of the spines of the basal prolongation of the uropoda is larger than the inner, but is not toothed on its inner margin. Length of the unique specimen (a female)  $2\frac{1}{4}$  inches.

*Hab.* Fiji Islands, Matuka (*H.M.S. 'Herald'*).

The carapace is marbled as in most of the species of the genus. In its dry condition it is of a light yellowish brown varied with darker colour.

*Gonodactylus trispinosus.* (Pl. III. fig. 10.)

*Gonodactylus trispinosus*, White, List Crust. Brit. Mus. p. 85 (1847);  
Dana, U.S. Explor. Exped. xiii. Cr. i. p. 623 (1852); Heller, Reise  
der Novara, Crust. p. 126 (1865); Miers, Cat. New-Zeal. Crust.  
p. 90 (1876).

The antero-lateral angles of the rostrum are produced into spines, which are nearly as long as the median spine. The fifth postabdominal segment is longitudinally corrugated; the

penultimate segment is apparently coalescent with the terminal, although the line of union is clearly indicated, and is armed with six convex tubercles. The terminal segment is suboblong, with the postero-lateral angles rounded; its upper surface is armed with three convex rounded tubercles disposed in a triangle; behind these the upper surface is marked with impressed lines, which reach to the posterior margin; the posterior margin has a median notch, and is divided by narrow fissures into about six truncated lobes. The styli-form termination of the dactylus of the raptorial limbs is very short and unarmed. The outer of the spines of the basal prolongation of the uropoda is larger than the inner, and is not armed with a tooth on its inner margin. Length of the typical specimen in the Museum collection (a male) about  $1\frac{1}{2}$  inch.

*Hab.* Swan River, one male (*Coll. Brit. Mus.*); Sharks' Bay, West Australia, in holes in coral (*H.M.S. 'Herald'*), two males.

This species is recorded by Dana from the Fiji Islands, and by Heller from Auckland. Hoffmann, in '*Recherches Faune Madagascar*,' Cr. p. 43, cites this species from the Mauritius; but he may have had specimens of *G. Folinii* or an allied form.

*Gonodactylus trispinosus*, var. *pulchellus*, nov.

By this name I designate a small male from Ceylon, presented to the Museum by E. W. H. Holdsworth, Esq., which may very probably constitute a distinct species; but I await the examination of a larger series of specimens before deciding this point. It differs from the typical *G. trispinosus* in the absence of corrugations on the median portion of the fifth postabdominal segment. The median spine of the rostral plate is absent, but may have been broken off close to the base. Length about  $1\frac{1}{4}$  inch.

*Gonodactylus glyptocercus*.

*Gonodactylus glyptocercus*, Wood-Mason, Proc. Asiatic Soc. Bengal, p. 232 (1875); Ann. & Mag. Nat. Hist. (ser. 4) xvii. p. 263 (1876).

This species is only known to me by Mr. Wood-Mason's short notice in the '*Proceedings of the Asiatic Society of Bengal*,' according to which it is allied to *G. trispinosus*, but has the terminal postabdominal segment ornamented with two oval tubercles, bounded by an impressed invected line, and with a median basal cinquefoil-shaped one, and the two preceding segments symmetrically engraved with fine lines.

*Hab.* Nicobars.



*Gonodactylus Folinii.*

*Gonodactylus Folinii*, A. M.-Edwards, Nouv. Archiv. Mus. Hist. Nat. iv. p. 65, pl. xviii. figs. 8-11 (1868).

In this species the antero-lateral angles of the rostrum are prolonged into spines, which are shorter than the median spine. The first to fifth postabdominal segments are smooth; the sixth and seventh are coalescent; the anterior portion, corresponding to the sixth segment, bears four rounded tubercles, the outer of which are three-lobed; the posterior portion, corresponding to the seventh segment, has on each side a longitudinal and somewhat reniform prominence, which is externally convex, besides a less elevated median prominence. The margin of this segment is notched posteriorly, and is laterally divided into three obtuse rounded teeth. The dactylus of the raptorial limbs is greatly dilated at base; and its styli-form extremity is acute, and without teeth on its inner margin. Length 0·02 metre (about  $\frac{3}{4}$  inch).

*Hab.* St. Vincent (*Mus. Paris*).

There are in the British-Museum collection a male from the Mauritius (*R. Templeton, Esq.*) and two small specimens, without definite locality, from the 'Herald' collection, which belong to this or a closely allied form. They differ, however, in the greater relative length of the antero-lateral spines of the rostrum, in the less prominence of the two teeth of the posterior margin adjoining the median notch, and the greater prominence of the basal dilatation of the dactyli of the raptorial limbs. Length of the Mauritius specimen rather more than  $\frac{3}{4}$  inch.

*Gonodactylus excavatus*, sp. n. (Pl. III. figs. 11, 12.)

The antero-lateral angles of the carapace are prominent and almost acute. The antero-lateral spines of the rostrum slender, but shorter than the elongated median spine. The fifth postabdominal segment is smooth and similar to the preceding; the sixth is armed with six somewhat irregular longitudinal prominences, which are separated by deep intervening spaces, and are confluent distally; the terminal segment is deeply and widely excavated posteriorly, and is armed above with five prominent, smooth, longitudinal, obtuse keels, the two on either side of the median one being longest, and reaching to the hinder margin of the postero-lateral lobes of the segment. The basal dilatation of the dactyli of the raptorial limbs is very prominent, and the styli-form distal portion slender and without teeth on its inner margin. Length about  $\frac{3}{4}$  inch.

A small male example, without locality, is in the Museum from the collection of H.M.S. 'Herald.'

*Gonodactylus furcicaudatus*, sp. n.  
(Pl. III. figs. 13-16.)

In this most remarkable species the carapace is very small, nearly oblong, without spines at its antero-lateral and postero-lateral angles, and the rostrum terminates in a slender median spine, and its antero-lateral angles are acute, as in so many *Gonodactyli*. The exposed thoracic segments and first five postabdominal segments are of the usual form; the sixth is armed with six smooth longitudinal prominences, the two median being somewhat larger than the rest. The basal portion of the terminal segment is very short and transverse, and has the appearance of having been suddenly broken off; its distal end is perforated with a series of pits, about four of which are placed in a transverse series above the base of the terminal portion of the segment, and one or two on each side of it; this terminal portion is composed of two slender spines, which are in close contact or partially united at base, and slightly divergent distally. The eye-peduncles are rather prominent and subcylindrical, the antennules and antennæ slender. The slender dactyli of the raptorial limbs are considerably enlarged at base and without spines on the inner margin. The rami of the uropoda are fringed with close hairs; and the basal prolongation ends in a very strong compressed terminal and a small and slender lateral spine. Length of the largest specimen (a female) 1 inch 2 lines.

*Hab.* —?

Four females and two males are in the collection, obtained in the voyage of H.M.S. 'Herald;' but their habitat has not been preserved. The appendages of the thoracic limbs are slender and linear, as in all the *Gonodactyli*.

On account of the remarkable abbreviation of the terminal segment, I had at first placed this form in a distinct genus under the name of *Mesacturus*; but as in all its other characters it belongs to *Gonodactylus*, and as in the *Gonodactyli* the form of this segment is subject to considerable variation, it seems better to include it in this latter genus.

#### APPENDIX.

*Lysiosquilla acanthocarpus*. — In a series of Crustacea selected from the collection lately exhibited in the India Museum, South Kensington, specimens of the following

Squillidæ occur—*Lysiosquilla acanthocarpus*, *L. maculata*, *Squilla nepa*, and *S. raphidea*, all from Penang, collected by Dr. Cantor. The first mentioned is of especial interest, as but a single specimen, from Port Essington, Australia, previously existed in the collection of the British Museum. A close examination of the types of *L. acanthocarpus* and *L. spinosa* (*L. tricarinata*), which are dried and not in good condition, now convinces me that these species approach *L. Brazieri* in having the appendage of the antepenultimate joint of the last pair of legs less dilated than those of the two preceding pairs. As, however, Latreille, Kessler, and De Haan, in their figures and descriptions of *L. scolopendra*, *L. eusebia*, and *L. latifrons*, represent the appendages of all the legs as equally dilated, this character cannot be supposed to be constant in all the species referable to Latreille's old genus *Coronis* (sect. 2 of my *Lysiosquilla*); nor, on the other hand, can it be sexual, as the type specimen of *L. Brazieri* is a female, and the specimen of *L. spinosa* in the Museum collection a male. In *L. acanthocarpus* there are five, not six, spines on the upper surface of the terminal segment.

*Lysiosquilla spinosa*.—I have received from Mr. T. W. Kirk, of the Colonial Museum, Wellington, New Zealand, copies of his recently published "Additions to the Carcinological Fauna of New Zealand," and "Notes on some New-Zealand Crustaceans." In the former paper is a figure of his *Squilla indefensa*, which leaves me in little doubt that I was right in regarding this species as identical with *Lysiosquilla spinosa*, the diagnosis of which Mr. Kirk had probably no opportunity of referring to. In the second paper the occurrence of *Squilla armata* in Wellington Harbour is recorded.

Of special interest, as relating to the distribution of the marine Crustacea, is the discovery by Mr. Kirk of several northern and arctic species (*Calocaris Macandreae*, *Portunus pusillus*, *Ebalia tumefacta*, *Podocerus cylindricus*, *Pleustes panoplus*, and *Caprella lobata*) in the New-Zealand seas.

If these identifications have been made from the descriptions only, and not from the comparison of actual specimens, I should hesitate to believe in the coexistence of so many species not yet recorded from intermediate localities in regions so widely separated.

The occurrence of *closely allied* species in the northern and southern hemisphere is not uncommon; but with very few exceptions (*Pinnotheres pisum*, *Lysianassa magellanica*) the species hitherto known to occur at once in the northern and southern hemispheres are such as have an almost cosmopolitan range.

It is right, however, to add (as I have already noted in the Introduction to my Catalogue of the New-Zealand Crustacea) that Dr. Günther (P.Z.S. 1871, pp. 653, 673) mentions several species of fishes common both to the British and Antarctic seas; and as our knowledge increases a parallel distribution of the marine Crustacea may be ascertained.

*Squilla mantis*.—In the text I have cited Latreille as the earliest authority for this species, because the *Cancer mantis* of Linnæus (Syst. Nat. p. 1054, 1766) and *Squilla mantis* of Fabricius (Ent. Syst. ii. p. 511, 1793) are described in such general terms that their diagnoses might apply to almost any species of the genus; and, indeed, it is evident from the synonymical references and habitats given by them ("in mare Asiatico, Indico, Mediterraneo") that they confounded several distinct species under this name.

#### EXPLANATION OF THE PLATES.

##### PLATE I.

- Fig. 1. Dactylus of raptorial limb of male *Lysiosquilla maculata*.
- Fig. 2. Dactylus of the raptorial limb of a female.
- Fig. 3. *Lysiosquilla Brazieri*, Miers, adult female, nat. size.
- Fig. 4. Raptorial limb of the same.
- Fig. 5. Appendage of one of the penultimate thoracic limbs, magnified.
- Fig. 6. Appendage of one of the last pair of thoracic limbs, magnified.
- Fig. 7. *Lysiosquilla acanthocarpus*, Gray, female, nat. size.
- Fig. 8. Raptorial limb of the same.
- Fig. 9. Terminal segment, magnified.
- Fig. 10. *Lysiosquilla spinosa*, Wood-Mason, nat. size.
- Fig. 11. Raptorial limb of the same, magnified.
- Fig. 12. Terminal segment and uropoda, magnified. The specimen figured is that to which Gray attached the name of *Coronis tricarinata*.

##### PLATE II.

- Fig. 1. *Chloridella microphthalmia*, M.-Edwards, adult male, nat. size.
- Fig. 2. Front of cephalic region of the same, showing the form of the eye-peduncles and of the rostral plate, magnified.
- Fig. 3. Raptorial limb, magnified.
- Fig. 4. Terminal segment and uropoda, magnified.
- Fig. 5. Front of the cephalic region of *Chloridella rotundicauda*, sp. n., showing the form of the rostrum and eye-peduncles, magnified.
- Fig. 6. Terminal segment and uropoda of the same, nat. size.
- Fig. 7. Lateral process of the fourth thoracic segment in *Squilla scorpio*, Latr.
- Fig. 8. *Squilla Dufresnii*, Leach (ined.), adult male, nat. size.
- Fig. 9. Lateral process of the fourth thoracic segment of the same, magnified.
- Fig. 10. Lateral process of the fourth thoracic segment in *Squilla prasino-lineata*, Dana?
- Fig. 11. Lateral process of the same segment in *S. mantis*, L.
- Fig. 12. Lateral process of the fourth thoracic segment in *S. empusa*, Say.
- Fig. 13. Lateral process of the same segment in *Squilla nepa*, Latreille.

PLATE III.

- Fig. 1.* *Pseudosquilla monodactyla*, A. M.-Edwards, magnified.  
*Fig. 2.* Dactylus of raptorial limb of the same, further magnified.  
*Fig. 3.* Front of cephalic region, showing rostral plate of *P. oculata*, Brullé, magnified.  
*Fig. 4.* Terminal segment and uropoda of the same, magnified.  
*Fig. 5.* Front of cephalic region, showing rostral plate of *P. ornata*, Miers, magnified.  
*Fig. 6.* Terminal segment and uropoda of the same, magnified.  
*Fig. 7.* Front of cephalic region, showing rostral plate of *Pseudosquilla ciliata* (Fabr.), magnified.  
*Fig. 8.* Terminal segment and uropoda of the same, magnified.  
*Fig. 9.* Terminal segment and uropoda of *Gonodactylus graphurus* (White, ined.), Miers (magnified).  
*Fig. 10.* Terminal segment and uropoda of *Gonodactylus trispinosus*, White (ined.), Dana (magnified).  
*Fig. 11.* *Gonodactylus excavatus*, sp. n., magnified.  
*Fig. 12.* Terminal segment and uropoda of the same, further magnified.  
*Fig. 13.* *Gonodactylus furcicaudatus*, sp. n., magnified.  
*Fig. 14.* Penultimate and last postabdominal segments, further magnified.  
*Fig. 15.* Terminal segment, viewed from behind, showing the pits in its posterior surface, magnified.  
*Fig. 16.* Dactylus of one of the raptorial limbs, magnified.

X.—On the Terms *Polyzoa* and *Bryozoa*.

By the Rev. THOMAS HINCKS, B.A., F.R.S.

IN the last number of the 'Annals' Mr. A. W. Waters has raised afresh the question as to the comparative claims of the terms *Polyzoa* and *Bryozoa*. He decides in favour of the latter, and urges its adoption, in opposition to the general practice of English zoologists.

This would be, in my judgment, a retrograde step; it would involve injustice to a most able and original observer; and (as I shall endeavour to show) it is not warranted by the facts of the case.

Mr. Waters is evidently under the impression that those who adopt the name *Polyzoa* do so on the mere ground of its priority and are wholly unacquainted with the contents of J. V. Thompson's paper in which it was first introduced. He expresses his confidence that, as soon as they are let into the secret, they will hasten to transfer their allegiance to Ehrenberg!

In this he is certainly under a misapprehension: some at least of the strongest advocates for the retention of Thompson's name have not contented themselves with ascertaining

the date of his paper, but have also thoroughly mastered its contents, and, strange as it may seem to my friend Mr. Waters, have been much confirmed thereby in their opinion.

As to the question of date there is no room for doubt, and Mr. Waters does not suggest any. The term *Bryozoa* first made its appearance in the 'Symbolæ Physicæ,' in 1831; but Thompson's 'Researches,' in which he proposed the name *Polyzoa* for the type of structure which he had demonstrated in the polypide of the Ascidian zoophytes (for this I take to be what he intended) were published in 1830. And it must be remembered that his observations were made as early as 1820; so that he *really* anticipated not merely Ehrenberg's name, but the discoveries of Grant and Milne-Edwards, though the publication of his results was delayed. Those results are sufficiently remarkable in themselves, and we shall estimate them the more highly when we take into account the conditions under which they were obtained.

But Mr. Waters makes very light of "the bibliographical question of dates," and is confident that we have but to glance at the paper to convince ourselves that we have been thus far under a delusion. He lays it down that "Thompson did not indicate *any group of animals* by his term, and that all he meant by *Polyzoa* was *a single polypide*;" and he implies that to make the term a class-designation would be to give it a totally different sense from that which he intended. For proof of his position he thinks it unnecessary to go further than the title of the paper, "On *Polyzoa*, a new animal discovered as an inhabitant of some Zoophytes."

This view, it seems to me, rests on a complete misapprehension of Thompson's meaning. He used the term *Polyzoa* (in opposition to *Hydra*) to denote *a distinct type of structure*, which he had demonstrated, and not as the mere name of the single zooid. This is evident from the following, amongst other passages:—"The *Polyzoa* will probably be found in many dissimilar genera of the zoophytes, and even mixed up with *Hydra* in some; . . . and hence this discovery must be the cause of extensive alterations and dismemberments in the class with which they have hitherto been associated. . . . I shall merely indicate here in a general way the whole of the *Flustraceæ*, in many of which I have clearly ascertained the animals to be *Polyzoæ*;" which is equivalent to saying that they exhibited the new type of structure, and were thus distinct from the *Hydræ*. In a word, *Polyzoa*, as he uses it here, is essentially a class-designation, and not the name of a mere structural element.

His *Polyzoæ* were polypes exhibiting a molluscan organization, as distinguished from the *Hydræ*; that is, they were strictly a CLASS.

The following passages may be added, as showing clearly the sense in which Thompson used the term *Polyzoa*:—"The other species of *Sertularia* in which the animals have been determined to be *Polyzoæ* may, . . . perhaps, be referred to *one* genus." "The present Memoir has for its object to demonstrate another form of animal not hitherto known, and which, while it must be allowed to belong to a new type of Mollusca Acephala, resembles exteriorly in some manner the *Hydra*; this animal has been designated by the name *Polyzoa*."

In this passage both *Hydra* and *Polyzoa* are used to denote *types of structure*, and not *elements of the compound organism*.

In the prospectus of the whole work, we find the following as the subject of the tenth memoir:—"Animals of some *Cellariæ*, *Tubuliporæ*, and *Flustracæ* proved to be *Polyzoæ*." To substitute *polypides* (in the mere sense of *single zooids*) for *Polyzoæ* in this sentence would be to render it perfectly unmeaning.

As to the mere form of the word, it seems to me to be a point of the very smallest moment; and Mr. Waters lays no stress on it. No doubt *Polyzoæ* would be the proper reading, if we must of necessity accept Thompson's original error in the construction of the word. But it is surely allowable to alter the ending, and so bring the term into harmony with our present usage. In doing so we retain all that is essential and we leave the honour with him to whom it is justly due.

Thompson's name, then, has every title to adoption; and I venture to think that English zoologists would be little true to their duty if they were to sacrifice the claim of a most able and accurate, though isolated and unobtrusive, investigator, because the majority have thus far failed to recognize it.

I trust that Mr. Waters may find reason to reconsider his opinion; he must certainly adduce some stronger arguments before the "*Polyzoists*" will be at all likely to change theirs.

XI.—*The Sponge-fauna of Norway ; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. SOLLAS, M.A., F.G.S., &c.

[Plate VI. & VII.]

IN the spring of the year (1879) my friend the Rev. A. M. Norman placed in my hands for description the fine collection of sponges which he had dredged the previous year from the coast of Norway.

This rich material placed completely at my disposal, unhampered by restrictions, has proved so fertile in interesting results that, even with the expenditure of the whole of my leisure time, I have as yet succeeded only in making a beginning to the work of its investigation. It would be useless, however, to defer publication till the investigation is complete ; by that time many of the new species which occur in the collection would in all probability have been discovered and described by others, as, indeed, in one or two instances has happened already, and a large part of the labour which has been spent upon them would thus be entirely thrown away.

As regards the general conditions under which the specimens lived, and the circumstances under which they were obtained, I cannot do better than quote nearly entire the graphic description by Mr. Norman himself; he says\*, "The district embraced was, speaking roughly, for I do not know the exact mileage, from 15 miles north to 15 miles south of Bergen—the Fiord chosen to the north being Oster Fiord, and the dredging in the south terminating at Kors Fiord.

"The weather was remarkably warm for the time of the year (May), and the circumstances for dredging altogether most favourable.

"Dredging in the Norwegian Fiords is a very different matter from what it is in the ocean round Shetland. In the latter case great expense must be incurred. Exposed to every wind which springs up, in the open sea, with an almost constant heavy Atlantic swell, the employment of a yacht or steamer is absolutely necessary, at least when dredging 20–40 miles from land. After tossing about in such a vessel for a week at sea it often happened that hardly twenty hours' dredging was practicable; and the greatest depth never exceeded 170 fathoms. Compare with this dredging in Norway. A small boat with four men will suffice for our purpose, if fur-

\* "The Mollusca of the Fiords near Bergen, Norway," by the Rev. A. M. Norman, M.A., in the 'Journal of Conchology,' Jan. 1879.



nished with suitable apparatus for lightening the labour of hauling in the dredge. In this we lie calmly on the lake-like surface of a narrow Fiord, where we are never more than about a mile from land, and let down the dredge to find a fauna unknown at Shetland, and approximating to that of the deeper parts of the North-Atlantic Ocean. It fairly astounds us at first, after what we have been accustomed to during five-and-twenty years' dredging in our own shallow seas, to drop the dredge over the boat-side and see 400 fathoms of line run out before a resting-place is found at the bottom, and this so near to shore that, letting out as much line again, it is actually possible to pull to shore from this great depth while the dredge lies still where it was let go, to land and haul it in from the rocks, and, if it does not catch (which it probably will do as it mounts the precipice), there to bring it in. It seems incredible until we have proved it, that in pulling over those few hundred yards of smooth surface to the shore we have passed over a precipice of more than 2000 feet, which lies hidden by the calm water which ripples against our bows."

*Present condition of the Sponges.*—The specimens have been all excellently preserved, some by drying, some by immersion in spirits—the latter still retaining so many details of their original histological character that I found it possible to obtain considerable information with respect to the nature of their soft parts.

*Mode of Preparation.*—In preparing specimens for microscopical examination I followed the ordinary methods for obtaining the spicules in the free state; but in cutting and mounting "sections" I adopted the processes which have hitherto, in this country at least, been confined to the examination of quite soft tissues. A piece was cut from the sponge large enough to contain a representative of each of its different tissues; this was then soaked in distilled water till its contained alcohol was as nearly as possible all extracted; it was then transferred to a strong solution of gum, in which it was allowed to stand for an hour or so; finally it was placed in the well of a freezing-microtome and frozen in the usual way. From the frozen specimen slices could be cut of any required thinness, the razor, strange to say, passing through the soft tissues and hard spicules with apparently equal ease.

The slices so obtained were variously treated: some stained, and some not, were mounted in glycerine of various degrees of strength; others were treated first with absolute alcohol, then with carbolic acid and turpentine and mounted in Canada balsam.

"Teasing" was resorted to in the case of some tissues with success, especially when it was found desirable to observe the behaviour of the tissue with reagents.

Altogether the various methods pursued have, I believe, succeeded in eliciting nearly all the information that could be extracted from the specimens; and that this is very far from being so complete as could be wished is to a great extent owing to the imperfect manner in which histological characters are exhibited in sponges which have been preserved in spirits without any previous treatment. Mr. Norman's specimens are perfect as spirit-specimens; they were not preserved with a view to submitting them to detailed histological examination. And here it may be worth while suggesting that if in the future it should be desired to preserve sponges with this object, a preliminary soaking in osmic-acid solution of .02 or .03 per cent. should be given to them before placing in spirits; this will effect nearly every thing that may be desired. With osmic-acid-treated specimens and the help of a freezing-microtome no difficulty should be experienced in obtaining an almost complete knowledge of the minute structure of any sponge.

We may now proceed with the work of determining and describing species, selecting to begin with the family Tetractinellidæ.

### Tetractinellidæ.

#### Genus STELLETTA, Sdt.

##### Species *Stelletta Normani*, nov.

*Sponge* (Pl. VI. fig. 1) more or less spherical in shape, becoming depressed cake-like with age, sessile, attached: in size an ellipsoidal form measured  $1\frac{6}{10}$  inch in length,  $1\frac{1}{10}$  in breadth, and  $1\frac{1}{10}$  in height; a cake-like form 2 by  $1\frac{1}{2}$  by  $\frac{3}{4}$  inch. From the surface of the sponge the distal ends of long acerate spicules project erectly, rendering it hispid; trifid spicules accompany the acerates, and, expanding into triradiate heads with simple or bifurcated rays at about one and the same level, form a network-like covering concentric with the surface and about  $\frac{1}{25}$  inch above it. Entangled among and adhering to the ends of these spicules are numerous Foraminifera, Annelids, and other organisms, as well as mineral particles; these give a dark greyish colour to the sponge, while its actual surface is of a yellowish-white colour. Oscules not apparent. Pores numerous, dispersed, minute.

*Skeleton*.—The skeleton consists of long-shafted spicules, minute hair-like spicules, and stellates. The long-shafted

spicules may be divided into two groups, the robust and the slender.

*Thick long-shafted Spicules.*—(i) a simple fusiform, straight or slightly curved, sharply pointed acerate, 0·235 inch long, 0·0025 inch broad (Pl. VI. fig. 4); (ii) trifid spicule with simple rays, shaft 0·16 inch long, 0·0025 broad, arms 0·03 inch long (Pl. VI. fig. 5); (iii) trifid spicule with bifurcated arms, shaft 0·11 inch long, 0·00375 broad, arms 0·0375 inch long (Pl. VI. figs. 6, 8).

*Thin long-shafted Spicules.*—(i) a long, slender, sharp-pointed acerate, 0·23 inch long (Pl. VI. fig. 11); (ii) trifid spicule with forward-directed arms, 0·215 inch long (Pl. VI. fig. 10); (iii) trifid, with arms recurved, anchor-like, 0·216 inch long (Pl. VI. figs. 9, 15); (iv) trifid spicule with forward-directed arms, 0·0625 inch long (Pl. VI. fig. 7). All these spicules are about 0·00125 inch broad. No. iv is no. iii of the preceding group in miniature.

*Stellates.*—These are of two kinds:—one somewhat larger, 0·0013 inch in diameter, with fine pointed rays (Pl. VI. fig. 13); the other smaller, 0·0004 inch in diameter, with blunt-ended rays and less regular in form (Pl. VI. fig. 12). Bowerbank's term "cylindro-stellate" may be adopted for the latter.

*Hair-like Spicules or Trichites.*—The "trichites," as these fine, immeasurably thin, hair-like spicules may be termed, are usually collected together in cylindrical sheaves or bundles, from 0·0016 to 0·002 inch long, and 0·0008 inch broad (Pl. VI. figs. 14, 16): each sheaf appears to represent a cell, and the spicules siliceous raphides within it; the unmetamorphosed protoplasm of the sheaf is chiefly accumulated in a layer at each end; one of these layers contains a nucleus with a spherical nucleolus. With age the trichites appear to become separate and are freed from their surrounding envelope. Their length is the same as that of the bundle which they form.

*Hab.* Marine.

*Loc.* Kors fiord, Station 23, depth 180 fathoms.

In transverse section the sponge is seen to consist of an internal "mark" (body-substance), separated by a layer of crypt-like cavities from an external well-marked cortex (Pl. VI. fig. 2). The cortex is about  $\frac{1}{15}$  inch thick; its lower half consists of a layer of bluish-white translucent tissue of great toughness and elasticity, and bearing a superficial resemblance to cartilage.

The "mark" is of a yellowish-grey colour, and traversed by canals which branch and become smaller towards the sub-

cortical crypts. The crypts are separated from each other by a number of fleshy pillars traversed by the shafts of long acerate and trifid spicules; they communicate laterally, to form a subcortical layer of winding passages.

Under the microscope the transverse section shows an outermost structureless membrane succeeded by a layer of minute stellates\*, the two together having a thickness of 0.0004 inch (Pl. VII. fig. 18, *a*). A layer of connective tissue with scattered stellates and of variable thickness succeeds.

The next layer, 0.03 inch thick, consists chiefly of trichite sheaves arranged in packets—the spaces around and between the packets, but not about the separate sheaves, being filled up with gelatinous connective tissue, the corpuscles of which are fusiform (Pl. VII. fig. 18, *b*).

The cartilaginous-looking layer (Pl. VII. fig. 18, *c*) before mentioned next succeeds; it is about 0.03 inch thick, and consists of long fusiform transparent hyaline fibres with a more refringent, faintly bluish, axial thread: these appear to be muscle-fibres, and form variously oriented fasciæ lying chiefly in a plane parallel to the general surface of the sponge (Pl. VI. fig. 3).

Just within the proximal edge of the preceding or muscular layer is a discontinuous row of large cells, variable but chiefly elliptical in form, and provided with a large oval nucleus containing some fluid and a spherical nucleolus (Pl. VII. figs. 18, *f*, & 26).

The inner or proximal face of the muscular layer is covered by an epithelial membrane bearing round nuclei.

The "mark" has a very different appearance from that of the gelatinous connective tissue which forms a large part of some sponges; it consists of finely granular protoplasm, which readily stains with reagents: about the borders of the canals it appears fibrous, owing to the presence of a number of granular fusiform corpuscles arranged in parallel order; further away from the canals nuclei present themselves similar in appearance to those which occur in the cells on the innermost face of the muscular layer; and in some cases the outlines of large elliptical cells can be traced about these nuclei; but more often the borders of the cells are obscure (Pl. VII. fig. 24).

The pillars of the crypts are chiefly continuations upwards of the mark; but they also contain muscular fibres, lying longi-

\* Whether the external membrane represents a layer of plate-like epidermis, or whether it and the stellates together constitute the epidermis, is by no means clear. The stellates have much the appearance of being the contents of epidermal cells.

tudinally, which have found their way down from the muscular layer. It is through the pillars that the long-shafted spicules pass on their way to the surface.

The large elliptical cells of the underside of the muscular layer are continued out of it down the sides of the pillars and under the floor of the crypts.

The cortex is traversed by the "intermarginal cavities" of Bowerbank, or, as I shall term them, the "cortical funnels" or "chonæ"\*. They consist essentially of a tube divided by a sphincter into a shorter proximal and a longer distal part, the "ectochone" and "endochone" respectively (Pl. VII. fig. 18, e). The ectochone is cylindrical or acutely conical for the greater part of its length, its proximal end being either the hemispherical termination of the cylinder or the rounded apex of the cone; its distal end is greatly expanded beneath the dermal layer, and produced laterally into canals from which smaller canals proceed and terminate in the pores of the surface, either immediately or after once more subdividing into still smaller canals. The endochone is a more or less hemispherical dome, which may be prolonged downwards as a very short cylindrical or conical tube, and which opens freely into the subcortical crypt. Generally each crypt is furnished with two or more funnels. The distal half of the ectochone lies in the layer of trichite sheaves; its proximal half and the whole of the endochone lies in the muscular layer of the cortex. The funnels are lined by an epithelial layer, outside which is a layer of concentric muscle-fibres; but when the ectochone traverses the layer of trichite-sheaves, the concentric muscles are replaced by gelatinous connective tissue containing fusiform corpuscles with nuclei.

*Arrangement of the Spicules.*—The long-shafted spicules which occur in the mark are chiefly robust acerates, gathered together into loose fibres, which exhibit no regular arrangement; on approaching the cortex, however, the fibres arrange themselves along radii more or less at right angles to it, pass through the pillars of the crypts, traverse the cortex, and project beyond it. At the same time trifold spicules put in an appearance, their distal triradiate ends lying imbedded at all levels in the cortex, or expanding at some distance outside it. Where the fibres pass out of the sponge their constituent spicules have so much diverged from one another that the fibre-like form is lost; the dermal layer of the sponge is slightly raised, tent-like, about the fibre where it emerges. The small trifold spicules (Pl. VI. fig. 7) are almost con-

\* χώνη, a funnel.

fined to the upper corners of the crypts, to which they serve as a kind of groin; the arms of large trifids sometimes occur in the same position, and where both are absent their place is sometimes supplied by a projecting spur produced from the shaft of one of the robust trifids (Pl. VI. fig. 8).

*Stellates*.—The cylindro-stellates are most abundant in the dermal layer, where the sharp-rayed forms are rare; both kinds of stellates are thickly strewn around the walls of the crypts, and both are rare in the interior of the mark. The sharp-rayed forms preponderate in the mark.

*Trichites*.—The trichite sheaves occur as the chief constituents of the outer half of the cortex; they accompany the large spicules through the pillars of the crypts, and are abundantly dispersed throughout the general substance of the mark.

*Foreign Bodies*.—The mark contains a surprisingly large number of foreign bodies imbedded in its substance. The nature of these included bodies is very various; but, for the most part, they consist of tests of Foraminifera, Radiolaria, and Diatoms, and the calcareous and siliceous spicules of a variety of other sponges, including an occasional *Geodia* globule.

### Observations.

1. *The Muscular Layer*.—Before proceeding to describe this a little more fully than we have yet done, it may be worth while giving a short account of observations which have been already made by others on the occurrence of muscular tissue in the sponges.

*Lieberkühn*\* appears to have been the first to draw attention to the resemblance between certain sponge-tissues and unstriated muscle-fibre, as in his description of the fibrous layer of the cortex in *Tethya lyncurium*, where he says that the fibres of this layer may be regarded as related to the so-called organic muscle-fibre of the higher animals.

*Oscar Schmidt*† follows, quoting *Lieberkühn*, confirming his observations, and extending them to other species, *ex. gr. Ancorina cerebrum*, Sdt.

*Kölliker*‡ likewise describes the muscular tissue of certain rind-sponges.

*O. Schmidt*§ again discusses this subject, confirming, by his own observations on the intermarginal cavities of *Geodia gigas*, Sdt., those made by Bowerbank on his *Geodia Baretii*,

\* *Lieberkühn*, 1859, Archiv f. Anatomie u. Physiologie, p. 523.

† *O. Schmidt*, 1862, Die Spong. d. Adriatischen Meeres, p. 43, pl. iv. fig. 1, a, b.

‡ *Kölliker*, 1864, Icon. Histolog. i. Heft, p. 48.

§ *O. Schmidt*, 1866, Adriat. Spong. ii. Supplem. p. 3.

from which it appeared that the iris-like diaphragms extending across these cavities are capable of spontaneous contraction and expansion, so as to vary at will the size of the central lumen; and hence he draws the obvious inference that the fusiform fibres composing these diaphragms are not only morphologically similar to muscle-fibres, but physiologically as well; from this he proceeds to the conclusion that the fibres of *Tethya* and other rind-sponges are likewise muscle-fibres.

Häckel\* does not deny that the fusiform fibres are both irritable and contractile, in the sense of shortening in the long and broadening in the transverse direction; but he maintains that true muscle cannot be evolved without a simultaneous differentiation of nerve-tracts; and since specialized nerve-tracts do not exist in sponges, he would call the contractile fibres in question "neuro-muscles."

Carter† describes the fusiform cells, referring to his figures in the Ann. & Mag. Nat. Hist. 1872, vol. x. pl. vii. figs. 9, 10, in illustration. These cells are less specialized than those to be met with in many other instances (they resemble fusiform connective-tissue corpuscles); but Carter decides to regard them provisionally as muscular.

F. E. Schulze‡ figures and describes fusiform cells also from an *Aplysina* (*A. acrophoba*); he follows Häckel in refusing to designate them as muscle-fibres, preferring the term "contractile fibre-cells."

Carter§, in his account of *Axos spinispiculum*, Carter, describes some fibrillated fibres which he conjectures may be muscular, especially as they lie parallel to each other and are not united as in elastic tissue.

In *Stelletta Normani* the fibres are the best marked I have yet met with in any sponge, and they likewise most closely resemble the organic muscle-fibres of the higher animals; they are about 0.0066 inch long and 0.0003 broad, fusiform, hyaline, colourless, and of sharply marked contour; their nucleus or axial thread, as it may be more correctly termed, is fusiform, homogeneous, faintly bluish in colour, highly refringent, and 0.0035 inch long (Pl. VII. fig. 20). With polarized light the fibres behave like uniaxal crystals. Treated with acetic acid or boiled in water they undergo no appreciable change; but potash and nitric acid produce well-

\* Häckel, 1872, Die Kalkschwämme, p. 414.

† Carter, 1875, Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. p. 36.

‡ Schulze, 1878, Zeitschrift f. wiss. Zool. p. 394, pl. xxii. fig. 13.

§ Carter, 1879, Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pp. 287 and 290, pl. xxv. figs. 6-8.

marked effects. Thus on adding a 5 or 10 per cent. solution of potash to a fragment of the teased-out tissue, the fibres at once became swollen, those which were previously curved straightened themselves out, and simultaneously the axial thread almost completely disappeared; on then adding a 10 per cent. solution of nitric acid the fibres at once contracted, and the axial thread became more visible than it had been before; again adding potash the fibre expanded; again nitric acid, and it contracted; and as often as one or the other reagent was applied, so often the same results were produced. With strong acid the outlines of the fibres appeared to vanish, and a homogeneous substance remained behind, in which the axial thread remained wonderfully clear and distinct; on adding magenta, the threads stained deeply, but the matrix was not affected. The fibres can best be separated from their tissue by macerating thin slices for a few days in baryta-water or 1 per cent. chromic-acid solution, and then teasing out.

The muscular layer passes at its distal margin insensibly into gelatinous connective tissue with fusiform corpuscles. The change seems to be accomplished by the loss of a distinct border to the muscle-fibres, and the growth of the fusiform axial thread at the expense of their hyaline portion; at the same time a distinct but small nucleus and nucleolus become clearly visible in the axial thread, which has also acquired a granular character (Pl. VII. fig. 17).

The muscles of the sphincter are darker than those of the rest of the muscular layer, owing to the increased size and proximity of their axial threads and to the development of fine granules in their hyaline exterior.

With carmine or magenta the axial threads of the muscle-fibres are easily stained, but the hyaline part not at all; hence when a section of the muscular layer is stained, the sphincters are made very prominent, since their abundant nuclei lead them to acquire a very dark colour.

We have applied the term muscle-fibres to the structures just described, because they are morphologically similar to the fibres occurring in other animals to which no one hesitates to apply the term "muscular;" and the fact that, slightly modified, they enter into the composition of the sphincters of the cortical funnels seems to show that they are functionally muscles as well. If, then, functionally and morphologically they resemble the organic muscles of other animals (and Kölliker, Oscar Schmidt, Häckel, and F. E. Schulze all seem agreed upon this point), one sees no good reason for withholding from them the name muscular. The specializa-



tion which converts an indifferent cell into a muscular fibre consists simply of a limitation of its contractility to a particular direction, so that it contracts in a longitudinal and broadens out in a transverse direction; its irritability is by no means suppressed; and, as is well known, both striated and unstriated muscles are capable of responding to thermal, chemical, and mechanical stimuli, quite independently of any nervous stimulus. This being so, all muscles, both those connected and those not connected with a nervous apparatus, may be regarded as neuro-muscles; and I, for my part, do not see what is to be gained by introducing this term into our nomenclature; it seems to imply that in the muscles of the higher animals something, some property, has been lost which was present in the muscles of such animals as are without a nervous supply; while we know this not to be the case. Of course a nerve is in a very different case; the tissue which has been converted into a nerve has not only gained an enhanced irritability, but has lost all trace of contractility; and if we found a nerve possessing contractility we might begin to think of coining some new term to distinguish it from the more highly specialized tissue. The inconvenience which would attend the recognition of muscles and "neuro-muscles" as distinctly different tissues may be illustrated by the observation of Engelmann, who states that the middle third of the ureter of the rabbit contains no discoverable nervous structures, and yet exhibits automatic and rhythmical contractions\*. Surely we cannot be expected to call the muscles of this part of the ureter by a different name from those otherwise quite similar ones of the rest of that structure.

Whatever our opinions with regard to nomenclature may be, the difficulty of explaining the manner in which the muscular layer of our sponge receives its stimuli remains the same; it is so important a tissue of the sponge, so perfectly differentiated, that one can hardly believe associated nerve-structures to be absent; and yet I have not been able to discover any trace of the presence of such structures. The large elliptical cells underlying the muscular layer and surrounding the subcortical crypts are wonderfully like ganglionic cells; but though they sometimes are elongated in one or other direction into a tear-drop shape, yet they are never prolonged into any distinct thread which might be regarded as a nerve. They do not seem to be nerve-cells; and perhaps they may be "ova;" but without tracing their development it is impossible

\* Foster, Text-book of Physiology, 1878, p. 83.

to say. On the whole I am disposed to regard them as the ordinary cells of the mark rendered very distinct by their occurrence in a tissue of markedly contrasted character. The spicules which extend beyond the surface of the sponge might perhaps suffice to convey a mechanical stimulus to the muscular layer, though this view is certainly attended with serious difficulties.

2. *Cortical Funnels or Chonæ*.—As the nomenclature of these organs is somewhat varied, one might almost say "poikilitic," a short account of the various terms in use may not prove superfluous. Most authors have founded their terminology on their ideas of the homology of these organs with the intermarginal cavities of Bowerbank; and while this plan has its special merits it suffers from the serious drawback that ideas as to homology are liable to change with advancing knowledge, the nomenclature must perforce change with them, and changes in nomenclature are most undesirable. Carter\* abstains from committing himself and merely terms these tubes the hourglass-shaped openings or hourglass cavities. Bowerbank† and Oscar Schmidt‡ regard them as corresponding to the intermarginal cavities of other sponges, such as *Chalina* and *Spongilla*, though they do not say why the "cortical funnels" and "subcortical crypts" should not both together be regarded as representing the intermarginal cavities. Hæckel§ appears to share the views of Bowerbank and Schmidt, but is anxious above all things to make it clear that the intermarginal cavities are nothing more than modifications of the ordinary "Astcanäle," one of the bladders of the "blasenförmige" type of "Astcanal" which has become specialized; and he prefers to call them "subdermal cavities," a term synonymous with Bowerbank's intermarginal cavities. Perhaps I am wrong in thinking that the homology of these cavities is not quite clear; but, however this may be, and without wishing "to ascribe any essential significance to them whatsoever," I still think they are sufficiently specialized parts of the canal-system and sufficiently different from other subdermal cavities to deserve a distinct name; and as "cortical funnel (*chone*)" is expressive without involving theoretical considerations, I have ventured to make use of it. Hæckel compares the sphincters of the funnels to the transitory sphincters which are formed by the closing of the dermal pores and gastral ostia of some calca-

\* Carter, Ann. & Mag. Nat. Hist. 1869, ser. 4, vol. iv. p. 13.

† Bowerbank, Brit. Spong. vol. i. p. 101.

‡ O. Schmidt, Adriat. Spong. ii. Suppl. p. 4.

§ Hæckel, Kalkschwämme, p. 236.

reous sponges. That an analogy exists is indubitable; but the sphincters of *Geodia* and the like are not transitory, any more than those of the ostia of some sponges, and they are besides composed of far more highly specialized muscle-fibres, arranged in a much more complex layer than is the case with the fusiform contractile cells which serve to close the dermal pores or ostia of any sponge which I have examined.

The following table gives the equivalent terms used by different authors, in four columns: the first gives the terminology of Bowerbank, O. Schmidt, and others; the second that of Carter and partly of Johnston; the third of Hæckel; and the fourth that adopted here.

1.	2.	3.	4.
Pores.	Apertures.	Hauptporen.	Pores.
Distal end of intermarginal cavity.	Pores.		
Intermarginal cavity.		Hour-glass cavity. Subdermal cavity.	Cortical funnel (chone).

3. *The Trichites*.—These spicules form a layer which is completely homologous with the layer of globates in *Geodia* and the like; and we may regard the trichite sheaf itself as homologous with the globate spicule: in the one the trichites have a radiate arrangement, and are fused together in a round ball; in the other they remain separate from each other and, lying parallel one with another, form a cylindrical bundle.

Certain structural differences distinguish the trichite-layer from the globate, independently of differences in the spicular elements themselves; thus in the *Geodia*-type of rind the globules are united by ligaments of fine sarcodic (muscular?) filaments, while in our *Stelletta* the trichite sheaves are not connected with each other by any intermediate tissue, but simply lie loose in "pockets" of their layer. In both the globate and trichite layers, however, certain spherical cells lie amidst the spicules; in the trichite layer these cells are very similar to colourless blood-corpuscles, and possess a nucleus with a round nucleolus; the corresponding cells in the globate layer are of a somewhat different character, as will be noticed in our description of the *Geodia* rind.

In examining sections of the trichite layer one constantly meets with examples like that shown in Pl. VI. fig. 16, where the trichites remaining conjoined at one end have separated and diverged at the other, and, dividing the sarcode of this end between them, appear capitate with minute bead-like particles of it.

Trichite sheaves are common in a variety of sponges, especially among the Esperiadæ. Oscar Schmidt \* has described the structure of those which occur in *Esperia lucifera*, Sdt. ; he, however, represents the nucleus as occurring at the side of the sheaf, and not at the end, as shown in my drawings. The enclosing cell-membrane is also more distinct in his figures than I have yet seen it. Possibly his specimens represent an earlier stage in the history of the sheaf than mine, and the nucleus may subsequently become transferred from the side to the end of the cell. In Schmidt's fig. 21, which represents a mature cell, this, however, does not appear to be the case, and we must probably fall back on inherent differences in the spicule-sheaves of the two sponges.

4. *Foreign Particles*.—The congregation of foreign particles on the exterior of the sponge, and their abundant distribution within it, are very striking facts, though not by any means confined to this species or genus ; as one observes the numerous remains of organisms imbedded in the sarcode of the mark one can scarcely refrain from regarding them, like the wings of flies in a spider's web, as the remnants of previous feasts. The cortex is so admirably adapted for preventing the entrance of foreign bodies, especially of the size of those under consideration, that it is difficult in the extreme to see how those within the mark can have found their way there unless through the cooperation of the sponge itself. If this theoretical view be the true one, then we may further regard the forked ends of the projecting spicules as serving not only for a means of defence, but as actual traps for capturing prey and so securing a constant supply of highly proteinaceous food for the sponge.

5. *Classification*.—Of all the various species of the genus, *Stelletta Normani* is provided with the most complete equipment of spicules ; and no difficulty is likely to be encountered in its identification.

The following list of the already published species of *Stelletta* may prove useful for reference. I have not included in it those species of Bowerbank's *Ecionema* and *Tethya* which may probably turn out to be *Stelletta*, because I think this genus cannot last much longer without undergoing modification, and I am anxious not to transfer Bowerbank's species to it till both it and they have been subjected to revision.

\* Zoologische Ergebnisse der Nordenfahrt vom 21. Juli bis 9. September 1872, p. 120, pl. i. figs. 19-21.

Table of the Species of *Stelletta*.

## I. Species possessing ternate spicules with furcate rays.

*S. immunda*, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 3. Syn. *S. Wageneri*, Sdt.

*S. Helleri*, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. fig. 8.

*S. aspera*, Carter, 1871, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. pl. iv. figs. 7-13.

*S. lactea*, Carter, 1871, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. pl. iv. figs. 17-21.

*S. mucronata*, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iv. fig. 2.

*S. scabra*, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iv. fig. 5.

*S. agariciformis*, Sdt., is *Thenia* (Gray) *Wallichii* (Perceval Wright).

*S. discophora*, Sdt., and *S. mammillaris*, Sdt., are probably *Geodia*.

## II. Species without furcated ternates, with ternate anchor-like spicules.

*S. dorsigera*, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. figs. 6, 7. (Doubtful whether genuine recurved rays.)

*S. Grubii*, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 2. (Rays "*raro furcatis*").

*S. pachastrelloides*, Carter, 1876, Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. pl. xv. fig. 40.

*S. pumex*, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. fig. 9.

## III. Species without either furcate or anchor-like ternate spicules.

*S. Boglicii*, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 3.

*S. pathologica*, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iii. figs. 3, 4.

*S. anceps*, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, p. 31.

NOTE.—*S. euastrum*, *geodina*, and *intermedia* of Schmidt appear to belong to *Geodia*. O. Schmidt\* would regard as

\* III. Suppl. Spong. d. Adriat. Meeres, pp. 20, 21.

*Geodiæ* only those sponges which contain globates, but no stellates, either in the rind or parenchyma; it is to be feared that the genus *Geodia* would be denuded of the majority of its species if this definition were rigidly carried out.

## EXPLANATION OF THE PLATES.

### PLATE VI.

- Fig. 1.* *Stelletta Normani*, sp. nov. A very little larger than natural size. (From a photograph.)  
*Fig. 2.* Transverse section ( $\times 2$ ). From a photograph.  
*Fig. 3.* Tangential section of the muscular layer, showing the arrangement of its fasciæ: *a*, sphincter; *b*, *c*, transverse section of spicules.  
*Fig. 4.* Robust acerate spicule.  
*Fig. 5.* Robust simple ternate spicule.  
*Fig. 6.* Bifurcated ternate spicule.  
*Fig. 7.* Small simple ternate spicule.  
*Fig. 8.* Bifurcated ternate, with a lateral spur.  
*Fig. 9.* Slender anchor-like ternate.  
*Fig. 10.* Slender ternate spicule, a variety with only two rays.  
*Fig. 11.* Slender acerate spicule. Figs. 4-11 are all magnified 20 diameters.  
*Fig. 12.* Cylindro-stellate spicule.  
*Fig. 13.* Sharp-rayed stellate.  
*Fig. 14.* Trichite sheaf, mounted in Canada balsam. Figs. 12-14 are multiplied 435 diameters.  
*Fig. 15.* Head of anchor-like ternate ( $\times 140$ ).  
*Fig. 16.* Trichite sheaf, mounted in glycerine, showing the divergence of the trichites, which are tipped with sarcodæ ( $\times 571$ ).

### PLATE VII.

- Fig. 17.* Fusiform corpuscle containing nucleus and nucleolus, from the connective tissue of the cortex ( $\times 435$ ).  
*Fig. 18.* Transverse section of the cortex: *a*, epidermal layer, with stellates; *b*, trichite layer; *c*, muscular layer; *d*, subcortical crypt; *e*, ectochone; *f*, layer of large granular cells ( $\times 15$ ).  
*Fig. 19.* Axial thread of a muscle-fibre from teased-out tissue which has been treated with strong nitric acid and then stained ( $\times 435$ ).  
*Figs. 20.* 20 *a*. Muscle-fibres isolated after treatment with lime-water by teasing ( $\times 435$ ).  
*Fig. 21.* Trichite sheaf in glycerine: *a*, terminal layer of sarcodæ, containing nucleus and nucleolus ( $\times 435$ ).  
*Fig. 22.* The frayed end of a teased-out bundle of muscle-fibre which had been treated with chromic acid ( $\times 435$ ).  
*Fig. 23.* Cells of the mark, surrounding a small canal ( $\times 217$ ).  
*Fig. 24.* Wall of a large canal, showing connective tissue with fusiform corpuscles and scattered stellates on the exterior, and granular cells further in ( $\times 217$ ).  
*Fig. 25.* Transverse section of a bundle of muscle-fibre ( $\times 315$ ).  
*Fig. 26.* Granular cells, with nucleus and nucleolus, from the lower face of the muscular layer ( $\times 435$ ).

[To be continued.]

## XII.—Notes on the Australian Maioid Brachyura.

By WILLIAM A. HASWELL, M.A., B.Sc. Edinb.

I HAVE been recently engaged in the study of the Brachyura Oxyrhyncha of the Australian coast, and, as a great deal that is new has been met with, and also a good many facts interesting from the point of view of geographical distribution, a summary of the results may be of sufficient interest to be given here.

Taking into account the comparatively unexplored condition of many parts of the coast of Australia (particularly the western and north-western coasts and the south coast of Tasmania), the total number of known species belonging to this group of Brachyura (nearly sixty in all) is unexpectedly large. Australia, however, cannot, as regards its marine zoology, be regarded as a single region. The affinities borne by the northern coast of the continent to the southern, as regards their prevailing types of marine life, are much less close than those which either of these provinces bears to regions much more remote, or at least separated from it by deep sea.

Taking those two faunas, the northern and the southern, separately, we find that there is in each a considerable comingling of the peculiarities exhibited by various other widely separated zoological provinces. Thus the southern fauna unites to its own peculiar forms some of the characteristics of New Zealand, of Japan, and, indirectly, of Europe; while the northern is very nearly related to that of the Philippines, Borneo, New Caledonia, and other islands of Melanesia, and, more remotely, to that of the Indian Ocean and Red Sea.

It is noteworthy that by far the greater number of the species characteristic of the northern region belong to the families Periceridæ and Parthenopidæ, while the southern species belong almost exclusively to the Inachidæ and Maiidæ.

As regards the species of Inachidæ, one of the most striking facts is the occurrence of three species of *Stenorhynchus* (*S. curvirostris*, A. Milne-Edwards, *S. brevirostris* and *S. fissifrons*, mihi), a genus of very wide distribution, though till quite recently regarded as peculiar to the northern hemisphere: one of these (*S. fissifrons*) occurs also in New Zealand; *S. curvirostris* has only been found in Bass's Straits; while the third species (*S. brevirostris*) ranges from Port Jackson at least as far north as Port Denison. A peculiar form belonging to this family is *Gonatorhynchus tumidus*, mihi, found in Port Jackson. It has the carapace subtriangular, rounded behind, the surface finely granulated, covered with hooked hairs, with a few minute spines on the lateral margins, and

various irregular smooth elevations on the dorsal surface; the rostrum is well developed and slightly deflexed, with triangular-fronted cornua; the eyes are non-retractile; and the orbit is protected above and behind by two converging spines, which are separated from one another and from the upper orbital margin by wide fissures; the epistome is transverse; the external maxillipedes have the third joint expanded at its external angle; the anterior limbs (in the male) resemble those of *Paramithrax*; and the ambulatory limbs are of moderate length, covered with slender hairs above, and have the terminal joint hooked at the apex.

The genus *Acheus* is represented by at least one species (*A. breviceps*, mihi), found in Port Jackson; and a species of *Oncinopus* (*O. angulatus*, mihi) occurs both in Port Jackson and in the far north. The genus *Halimus* is highly characteristic of Australia in its temperate portion, at least four species occurring on the coast of New South Wales and Tasmania, viz. *H. tumidus*, Dana, *H. spinosus*, Hess (*H. truncatipes*, Miers?), *H. laevis*, mihi, and *H. (Microhalimus) deflexifrons*, mihi. The last is distinguished from the ordinary *Halimi* by its small size and the absence of conspicuous spines on the lateral borders of the carapace. Other species of Inachidæ observed in Australia are *Camposcia retusa*, Latr., *Xenocarcinus tuberculatus*, White, *X. depressus*, Miers, *Huenia proteus*, De Haan, *H. bifurcata*, Streets, and *Menaethius monoceros*, Latr.

Among the Maiidæ one of the most noteworthy forms is a species from Torres Straits, which I have named *Chlorinoides tenuirostris*, distinguished from the genus (*Pseudochlorinus*?) represented by *Chlorinus aculeatus*, Milne-Edwards, *C. longispina*, De Haan, and *C. acanthonotus*, Adams and White, by the presence of a spine on the basal joint of the antennæ and the greater relative length and slenderness of the ambulatory limbs.

*Egeria Herbstii*, Milne-Edwards, and *E. arachnoides*, Rumph., seem to replace, in Torres Straits and on the eastern coast of Queensland, the *Stenorhynchi* and *Achei* of the temperate zone, and are associated with *Chlorolibinia gracilipes*, Miers, a species originally obtained by H.M.S. 'Herald' from the New-Guinea coast.

The genus *Paramithrax* (including *Leptomithrax*) is represented by five species, all seemingly confined to the temperate zone; these are *P. barbicornis*, Latr., *P. sternocostulatus*, Milne-Edwards, *P. Peronii*, Milne-Edwards, *Leptomithrax australiensis*, Miers, and *L. spinulosus*, mihi.

Among the other species of this family inhabiting the Aus-



ralian coast may be mentioned *Micippoides longimanus*, mihi, *Schizophrys aspera*, White, *Cyclomaia margaritata*, Stimpson, *Hyastenus oryx*, A. Milne-Edwards, *Micippa parvirostris*, Miers, *M. spatulifrons*, A. Milne-Edwards, *M. superciliosa* and *M. inermis*, mihi, and *Paramicippa spinosa*, Stimpson.

Among the Periceridæ the only genus represented is *Tiarinia*, of which there occur three species, all confined to the tropics.

The family Parthenopidæ, on the other hand, is very abundant in genera and species, by far the greater number of which are confined (so far, at least, as at present known) to tropical seas. Of the genus *Lambrus* (including *Parthenope*), there are no fewer than nine species; these are:—*L. longimanus*, Milne-Edwards; *L. turriger*, *L. hoplonotus*, *L. harpax*, and *L. calappoides*, Adams and White; *L. nodosus*, Lucas; *L. affinis*, A. Milne-Edwards; *L. spinifer* and *L. Sandroeckii*, mihi. There are two species of *Cryptopodia* (*C. fornicata*, Fabr., and *C. spatulifrons*, Miers), one of *Zebrida* (*Z. longispina*, mihi), two of *Gonatonotus* (*G. pentagonus*, Adams and White, and *G. crassimanus*, mihi), and one of *Harrovia* (*H. tuberculata*, mihi).

Sydney, Dec. 3, 1879.

### XIII.—Description of a new Genus and Species of Heteromerous Coleoptera. By CHARLES O. WATERHOUSE.

ON two or three occasions I have had brought to me for determination a small heteromerous beetle which appears to be always associated with grain of some kind, especially rice. The species appears to be not uncommon; but I have been unable to find any description of it. Specimens of the species have been in the British-Museum collection for many years, but without any name; and I have been unwilling to describe it, from the fact of its being widely distributed and therefore likely to have been in the hands of continental authors. Having again made an unsuccessful attempt to determine it, and being informed by Mr. F. Bates that he has it in his collection noted as a new genus, I now venture to name it as follows:—

#### Ulomidæ.

##### LATHIETICUS, n. gen.

General form of *Tribolium*. Mentum transverse, the anterior angles rounded, the front margin gently emarginate in the middle, the ligula not much projecting, transverse, emar-

ginate in the middle; the labial palpi short, the apical joint very large, one third longer than broad, subparallel (but narrowed at the base), truncate at the apex. The inner lobe of the maxillæ terminating in a very slender, acute hook, with a broad fringe within; the outer lobe slender, terminating with curved stiff hairs; the palpi stout, the penultimate joint subquadrate, the apical joint about twice and a half as long as broad, cylindrical, narrowed at the apex. Labrum extremely short. Epistoma trapeziform, emarginate anteriorly; the ocular canthus not projecting laterally beyond the eyes. Eyes moderately prominent, very coarsely granular. Antennæ nearly as long as the head; the two basal joints not visible from above; the 3rd joint the narrowest, about as long as broad; the 4th, 5th, and 6th joints transverse, each a trifle broader than the preceding; the 7th joint distinctly larger than the 6th; the 8th the largest (still transverse), the 9th and 10th a little narrower than the 8th; the 11th still narrower, somewhat flattened, obliquely truncate at its apex. The rest as in *Tribolium*.

*Latheticus oryzæ*, n. sp.

Parallelus, depressus, nitidus, piceo-flavus, thorace sat crebre evidenter punctato, elytris irregulariter punctato-striatis.  
Long.  $2\frac{1}{2}$ – $2\frac{3}{4}$  millim.

General form of *Tribolium ferrugineum*, F., but rather narrower, and with the head relatively larger and broader and more square in general outline. Forehead and middle of the epistoma gently convex; the former not very thickly but very distinctly punctured; the epistoma less distinctly punctured, about twice as broad as long, obliquely (but not much) narrowed anteriorly, declivous in front, impressed at the sides, emarginate in front; the ocular canthus not much encroaching upon the eyes. Antennæ rather short, thickest at the eighth joint, so that their general outline is somewhat fusiform. Thorax very little broader than the head across the eyes, a little narrower behind; very distinctly but not very thickly punctured; the angles obtuse; the sides somewhat straight, very finely margined. Elytra as wide as the broadest part of the thorax, parallel, their surface somewhat uneven or wrinkled; each elytron with four or five scarcely impressed lines, with somewhat large punctures, the lines somewhat irregular, or here and there interrupted. Legs rather slender.

*Hab.* Calcutta, "in rice" (*Brit. Mus.*); Arabia (*F. Bates*).

Mr. A. Fitch has shown me specimens of this species found in England. Mr. G. C. Champion has examples found in rice; but I do not know where they came from.

XIV.—On new British Graptolites.  
By CHARLES LAPWORTH, F.G.S. &c.

[Plates IV. & V.]

WITHIN the last few years many new forms of British Graptolites have been added to my collection. In the present paper I propose to give brief diagnoses of such of these undescribed forms as I find it necessary to refer to in the concluding portion of my memoir on the Geological Distribution of the Rhabdophora\*. At the same time it will be advisable to make such notes and observations upon the less perfectly understood species among those already described by palæontologists as may serve to bring our knowledge of these forms up to date. Such species as have mainly a classificatory or zoological value will be here passed over. Those forms alone will be noticed which are of interest from a stratigraphical or geological point of view—as indices of recognizable horizons in the vertical series of rock-formations, or as being remarkable for their extended geographical distribution.

The majority of the forms under review are from my own collection. One was sent me by Dr. Callaway several years ago. Two were collected by Mr. John Hopkinson, F.G.S., in the Lower Ludlow rocks of Siluria, in 1873, and were named by him at the same time†, but have hitherto remained unfigured and undescribed. The remaining species have been collected by myself at various times from the Lower Palæozoic rocks of Scotland, the Lake District, Wales, and the west of England.

Family **Monograptidæ**.

1. *Monograptus leintwardinensis*, Hopk. MS.  
(Pl. IV. figs. 1a–1d.)

*Monograptus leintwardinensis*, Hopkinson, Geological Magazine, 1873, p. 520, 1875, p. 561.

Polypary short and stout, never exceeding half an inch in length, with a maximum diameter of one twelfth of an inch. Virgula distally prolonged. Hydrothecæ inclined at an angle of about 40°, overlapping each other for half their length, short and tubular; free portion of each short, impressed proximally with a deep excavation, the upper sinus of which is prolonged into a

\* Ann. Mag. & Nat. Hist. 1879, 1880.

† Hopkinson, Geological Magazine, 1873, pp. 519, 520.

distinct and more or less flexuous horizontal spine; apertural margin short, concave, oblique, and destitute of ornamentation.

This peculiar little species is recognizable at a glance by its form and diminutive size, and more especially by the remarkable ventral spine, which does not originate from the denticle of the apertural margin (as is generally the case with this ornament), but proceeds from the upper angle of a deep excavation in the ventral margin of the theca, as in *Monograptus vomerinus*, Nich. This spine, although very slender, is always conspicuous, proceeding outwards to a distance occasionally equal to that of the entire width of the polypary itself. It appears to have been somewhat flexible; for no two consecutive spines lie precisely at the same angle of inclination. The distal prolongation of the virgula is general in this species; it rarely exceeds in length the polypary itself.

*Horizon and Locality.* *Monograptus leintwardinensis* occurs in great abundance in the Lower Ludlow rocks of Leintwardine (*Hopk.*), and in the same general horizon near Presteign, New Radnor, Ludlow, Buttington, &c.

## 2. *Monograptus Salweyi*, Hopk. MS. (Pl. IV. figs. 2 a, 2 b.)

*Monograptus Salweyi*, Hopkinson, Geol. Magazine, 1873, p. 520.

Polypary straight, rigid, of unknown length, having a general diameter of one twelfth of an inch, exclusive of the extension of the apertural spines. Virgula stout, distally prolonged. Hydrothecæ twenty-five to the inch, inclined at an angle of about 45°, straight, narrow, tubular, overlapping each other for four fifths of their length; free portion slightly expanded, with subvertical apertural margin furnished distally with a stout and rigid horizontal spine.

Only a single and fragmentary example of this form has been detected; but its characters are so unique that there can be no hesitation in assigning it a distinct specific title. The distal portion of the polypary only is preserved to us; and as there is no appearance of proximal contraction, it is impossible to speculate upon the total length. The most remarkable peculiarity of this species is afforded by the anomalous features of the apertural margin of the theca. The plane of the aperture appears to lie almost parallel with the ventral edge of the polypary, or but very slightly oblique; its inferior or proximal sinus is marked by a minute denticle, never very conspicuous. The edge of the aperture itself is concave and

somewhat patulous. From a point which, in the profile view, appears to be a little above the central point of its lateral aspect the apertural edge is prolonged into a stout and stiff horizontal spine, about one twelfth of an inch in length.

*Horizon and Locality.* Lower Ludlow rocks of Stanner Hall, near Ludlow (collected by John Hopkinson, Esq., F.G.S.).

### 3. *Monograptus Ræmeri*, Barrande.

(Pl. IV. figs. 5 a-5 e.)

*Monograptus Ræmeri*, Hopkinson, loc. cit. *suprà*.

Polypary short, stout, straight, and rigid, from half an inch to an inch in length, rapidly expanding from a blunted proximal extremity to a maximum diameter of one eighth of an inch. Virgula invisible. Hydrothecæ thirty to the inch, inclined at an angle of from  $30^{\circ}$  to  $45^{\circ}$ , long narrow tubes, overlapping each other for about four fifths of their length, and having a very oblique, slightly contracted and everted aperture, destitute of visible ornamentation.

Few examples of this species collected by myself or others exceed one inch in length; and the vast majority are under half an inch. The larger examples have their margins parallel in the distal moiety of their length. In the smaller examples the polypary is widest near its distal extremity. The proximal end is bluntly rounded, rarely pointed, and the first formed thecæ are spinose. The normal hydrothecæ are rounded tubes, about one eighth of an inch in length, overlapping each other throughout, except in the neighbourhood of the aperture. In well-preserved examples, and in the true profile view, the apertural margin is at right angles with the axis of the theca. It varies much, however, in its degree of obliquity, according to the slight variations in the direction of compression. There is a distinct appearance of contraction below the aperture in specimens in relief. The orifice itself is a little patulous, so that the lower margin appears denticulate in certain views (fig. 5 e).

This is certainly the British representative of Barrande's *Monograptus Ræmeri* of the Bohemian rocks; but whether it can properly be referred to that species is open to question. It has not hitherto been described from British strata.

*Horizon and Locality.* Lower Ludlow rocks of Adferton (Hereford) (Mr. Hopkinson), Lower Ludlow of Builth (Prof. Nicholson), Lower Ludlow of New Radnor and Presteign.

4. *Monograptus colonus*, Barr.

(Pl. IV. figs. 3 a-3 c, and figs. 4 a, 4 b.)

*Monograptus colonus*, Barr. Graptolites de Bohême, pl. ii. figs. 1, 2, 3; Nicholson, Quart. Journ. Geol. Soc. vol. xxiv. pl. xx. figs. 9, 10, 11.

In Plate IV. figs. 3 a-3 c I figure some examples of a peculiar species of Graptolite, which is the only British form known to me which distinctly approximates in its superficial characteristics to the typical *Monograptus colonus* of Barrande (Grapt. de Bohême, pl. ii. fig. 1). It agrees very closely with some Bohemian forms referred to Barrande's species examined by myself, but rarely exceeds the length given in the specimens figured. The marginal spines appear to be merely a mucronate extension of the apertural denticle, as in the Dichograptidæ. They are very distinct from the horizontal thecal processes exhibited by such forms as *Monograptus leintwardinensis*, &c.

Barrande's young example (*loc. cit.* fig. 5) must belong to a distinct species. It is not unlike the young form of *M. basilicus*, Lapw., or, as I have elsewhere suggested \*, may be identical with Suess's *Monograptus dubius*.

I know of no example of the present form, either British or Bohemian, in which the virgula is not greatly prolonged distally. This invariable feature, together with the characteristics of the closely-set hydrothecæ, distinguish it at a glance from all its congeners.

*Horizon and Locality.* Not uncommon in the Lower Ludlow beds of Vinnal and Leintwardine, Herefordshire.

5. *Monograptus galaensis*, Lapw., var. *basilicus*, nov.

(Pl. IV. figs. 6 a-6 d.)

*Monograptus colonus*, Lapworth, Ann. & Mag. Nat. Hist. 1880, vol. v. pp. 59, 60.

Polypary stout and straight, several inches in length, slowly augmenting in diameter to a maximum width of one eighth of an inch. Hydrothecæ sixteen to twenty to the inch, inclined at an angle of about 45°, with convex proximal walls overlapping each other for less than three fourths of their length; narrowing rapidly in the direction of the aperture, the margin of which is concave, very oblique, and destitute of ornamentation.

The proximal portion of the polypary augments its diameter very slowly, a length of several inches being attained

\* Lapworth, "Scottish Monograptidæ," Geol. Mag. 1876, p. 506.

before the fossil reaches its normal breadth. The hydrothecæ upon this younger portion agree in their general features with those upon the adult parts of the polypary, except that in certain views the apertural margin appears to be proportionally wider. When fully developed they are seen to be flattened tubes, which, in the profile view, are more than twice as wide at their point of origin as at their distal termination. The proximal wall of each is bent with an elegant convex curve, and is in contact with the distal wall of the preceding theca for about two thirds of its longitudinal extent. The apertural margin is at right angles to the axis of the hydrothecæ; it is sharply denticulate at its outer extremity, but never appears to be prolonged into a distinct marginal spine. The cast of the polypary (fig. 6 a) is identical with that of *Monograptus vomerinus*, Nich. In young forms it is narrower, and there is a distal prolongation of the virgula, occasionally equal in extent to that of the polypary itself. The test is smooth and of remarkable thickness.

This form appears to stand midway between the typical form of *M. galaensis*, Lapw., and *M. colonus*, Barr. From the former it is separated by the much greater size and thickness of the polypary, the angle of inclination and amount of overlap of the theca, and by the prolongation of the virgula in young examples. From the latter it is distinguished by the far greater length of the polypary, by the fewer hydrothecæ upon the same longitudinal extent, and by the form of the apertural portion of the theca and the absence of ornament.

*Horizon and Locality.* Common and well preserved in the zones of *Cyrtograptus Murchisoni*, Carr., and *C. Linnarssoni*, Lapw. (Wenlock), at Wellfield, Builth, river Onny, &c.

6. *Monograptus crenularis*, sp. nov.  
(Pl. IV. figs. 10 a-10 e.)

Polypary of great length, rigid, slightly curved throughout the whole of its extent; average width one sixteenth of an inch. Hydrothecæ arranged on the convex margin of the polypary, twenty to twenty-two to the inch, inclined at an angle of about  $15^{\circ}$  to the axis of the polypary, long narrow tubes, overlapping each other for less than half their length, slightly diminishing in diameter in the direction of the aperture, the margin of which is somewhat oblique, deeply concave and inornate.

The polypary in this species attains a total length of at least eight inches. It is almost straight throughout; the very

slight convexity of the proximal extremity is precisely similar to that in the adult portions. The width of the entire polypary, except near its initial extremity, is constant; but the length of the slowly tapering portion is occasionally as much as three or four inches.

In specimens preserved with their full relief the hydrothecæ are seen to be a little wider at their point of origin than near their outer orifice; and the general aspect of the polypary under this aspect reminds us somewhat of those of the group typified by *M. colonus*, Barr. In casts and compressed examples the distal portion of the theca appears as a wide perpendicular tube, lying parallel to the axis of the polypary, and occupying about one third of its total diameter. In these specimens the apertural margin is deeply concave, is very slightly oblique, and shows a rudimentary denticle.

This species is allied, on the one hand, to *Monograptus leptotheca*, Lapw., and, on the other, to *M. galaensis*, Lapw. It differs from the former in the shape and amount of overlap of the hydrothecæ. In the proximal portion of *M. crenularis* the hydrothecæ are twice as numerous for the same distance as in that of *M. leptotheca*; in the adult portion of the latter species they are more than twice as long as in the species under description. From *M. galaensis* the present form is separated by the form of the distal portion of the hydrotheca, which in the former species is strongly denticulate.

*Horizon and Locality.* Birkhill Shales. Zone of *Cephalograptus cometa* at Dobbs Linn, Crosscleuch, &c.

In the Upper Llandovery, Wenlock, and Lower Ludlow formations of Britain occur at least four doubtfully distinct, closely allied forms of *Monograptus*, which seem to represent the Bohemian species *Monograptus Halli* of Barrande. They all agree in the general shape of the hydrotheca, which is tubular, of subequal diameter throughout the whole of its extent, with a more or less expanded and everted aperture, the outer margin of which is broadly convex and frequently spinose. They differ from each other mainly in the size of the polypary, the number and amount of overlap of the hydrothecæ, &c. They are all easily distinguished from the type form of Barrande's *M. Halli* (see Pl. IV. fig. 9 a) by the inclination and form of the hydrothecæ. The first of these British forms seems to be peculiar to the Llandovery; the second and third are Wenlock forms, while the fourth doubtfully transgresses the limits of the Lower Ludlow. Their individual peculiarities are given in the following diagnoses.



7. *Monograptus crassus*, Lapw., sp. nov.  
(Pl. IV. fig. 8 b.)

*Monograptus Halli*, Barr., Carruthers, Geological Magazine, vol. v.; Lapworth, *ibid.* vol. iii. (1876), pl. xiii. figs. 1 a-1 d, &c.

Polypary straight, one tenth to one eighth of an inch in diameter. Hydrothecæ eighteen to twenty to the inch, short and stout slightly overlapping tubes, half as long again as broad, furnished with distinct horizontal spines.

I have hitherto followed Mr. Carruthers in his reference of this form to *Monograptus Halli*, Barr.; but there can be no question of its distinctness from Barrande's typical form, in which the hydrothecæ are very differently formed (comp. fig. 9 a.)

*Horizon and Locality.* Common in the highest beds of the Birkhill shales everywhere in South Scotland.

8. *Monograptus riccartonensis*, Lapw.  
(Pl. IV. fig. 8 c.)

*Monograptus riccartonensis*, Lapworth, Geological Magazine, vol. for 1876, pl. xiii. figs. 2 a-2 e.

Polypary never exceeding one twelfth of an inch in transverse diameter, proximal portion slightly recurved. Hydrothecæ twenty-four to twenty-eight to the inch, free, with direct walls, everted aperture, ornamented with a long and oblique spine.

A narrow species, with distant free hydrothecæ. Salter's species *M. Flemingii* was probably founded in part upon this form, partly upon the following species. They are both present in Salter's original locality of Kirkcudbright, the present form "in great plenty," while the next species is comparatively rare.

*Horizon and Locality.* Very numerous in the Wenlock strata of Riccarton and Kirkcudbright, rare in the Coniston Flags of Westmoreland, and in the Llandovery strata of Tieveshilly, county Down, Ireland.

9. *Monograptus Flemingii*, Salter.

*Monograptus Flemingii*, Salter, Quart. Journ. Geol. Soc. vol. viii. pl. xxi. figs. 5, 6, 7; Lapworth, Geological Magazine, 1876, pl. xx. fig. 8, a-d.

Polypary straight, one tenth to one eighth of an inch in diameter. Hydrothecæ twenty to thirty-six to the inch, overlapping each other for more than half their length, from three to four times as long as wide, with slightly curved separating walls, and greatly expanded apertural margin, which in com-

pressed specimens originates a long oblique and acuminate denticle, occasionally prolonged into a short spine.

Compressed examples of this form admit of immediate identification, as the distal portions of the theca form a series of broad acutely triangular denticles running down the ventral edge of the polypary, directed towards its proximal extremity and projecting outwards to a distance equal to at least one third of the diameter of the polypary itself.

Specimens from different localities vary greatly in the number of hydrothecæ upon the same longitudinal extent. The thecal walls are of the form of those of *Monograptus priodon*, Bronn. In young examples the polypary is short and stout, augmenting its original diameter with great rapidity, with closely approximated hydrothecæ.

This form may be distinguished at a glance from *M. riccartonensis*. It is more intimately allied to *M. crassus*, from which it differs principally in the form of the thecal walls, the greater eversion and denticulation of the apertural margin, and in the more closely set and overlapping hydrothecæ.

*Horizon and Locality.* Rare in the Riccarton beds of Roxburgh and Kirkcudbright, and in the Wenlock shales of Siluria; common in the Coniston Flags of Westmoreland.

#### 10. *Monograptus M'Coyi*, Lapw.

*Monograptus M'Coyi*, Lapworth, Graptolites of County Down, Trans. Belfast Nat. Field-Club, 1876-7, pl. vi. fig. 2, p. 130.

A diagnosis and figure of this form are given by M'Coy, in his 'Palæozoic Rocks and Fossils,' under the title of *Graptolites latus*\*. It is not unlikely that it may eventually be shown to be the species upon which Murchison founded his *Graptolites ludensis*, in which case the more recent title must be suppressed. In the adult form of the polypary the hydrothecæ are from four to five times as long as wide, and the denticle is short and destitute of ornamentation.

*Horizon and Locality.* Examples, apparently of this species, from the Lower Ludlow rocks of Siluria are preserved in the Ludlow Museum. M'Coy's original example was procured from the Wenlock (?) of Builth Bridge.

#### 11. *Monograptus Hisingeri*, Carr., var. *nudus*, var. nov. (Pl. IV. fig. 7a, b, c.)

*Monograptus Hisingeri*, Lapworth, Geological Magazine, 1876, pl. xii. figs. 1 a-1 c, &c.

This form has been already so minutely described (*loc. cit.*

\* M'Coy, Palæozoic Rocks and Fossils, pl. 1 B. fig. 7.

*suprà*) as to preclude any extended notice in this place. I formerly regarded it as the type form of Hisinger's *Graptolithus sagittarius*. The Swedish form to which Hisinger erroneously applied this title proves to be identical with my var. *jaculum*. The two forms united by myself under Carruthers's title are very distinct, the younger form differing from the older not only in the angle of inclination and the form and amount of overlap of the hydrothecæ, but also in the curvature and the greater diameter of the polypary. It may eventually be shown that they are distinct species. Meanwhile the younger form may conveniently be distinguished as var. *nudus*.

*Horizon and Locality.* *M. Hisingeri*, Carr., var. *nudus*, is rare in the Gala group and in the Grieston shales and Riccarton beds of the south of Scotland, the Tieveshilly beds of county Down, and the highest zone of the Coniston mudstones of Westmoreland.

## 12. *Monograptus Salteri*, Lapworth (non Geinitz).

*Monograptus Salteri* (Gein.), Lapworth, Geological Magazine, 1876, pl. x. fig. 8, a, b.

The fragmentary Graptolites for which Prof. Geinitz suggested this specific title ('Die Graptolithen,' s. 36), were collected by Mr. Salter from the rocks of Piedmont Glen, near Girvan (Quart. Journ. Geol. Soc. vol. xii. p. 173), and were originally referred by him to *Monograptus tenuis* (Portlock). I have recently ascertained that the whole of the strata visible in Piedmont Glen are of Bala age, and therefore of a geological date anterior to that of the advent of the family of the Monograptidæ. Forms of Leptograptidæ are rare in the rocks of the glen; and these, and not true Monograptidæ, were almost certainly the enigmatical examples noticed by Salter. Some well-preserved but fragmentary Leptograptidæ from the typical locality of Piedmont Glen, near Girvan, occur in the Hugh-Miller collection, preserved in the Museum of Science and Art, Edinburgh. They are labelled "*Graptolites tenuis*, Portlk.," and may have been the original specimens figured by Salter himself. The variation in the curvature of the figured specimens pointed out by myself is thus naturally accounted for—the Leptograptidæ being excessively slender and flexuous, varying greatly in the amount and the direction of their curvature under the most trivial extraneous influences, while among the Monograptidæ the curvature of the polypary is so constant in character and direction that it may be safely regarded as a specific peculiarity.

It is thus certain that the Graptolite to which I applied the

title *M. Salteri* cannot be identical with that for which the name was originally proposed by Prof. Geinitz. The name, however, is a convenient one. I propose, therefore, to retain it for the form to which it was originally applied by myself.

*Horizon and Locality.* *M. Salteri*, Lapw., is a very rare form, occurring in fragments in the Llandovery strata of Gala and Girvan, South Scotland.

13. *Cyrtograptus Linnarssoni*, sp. nov.  
(Pl. IV. figs. 12 a, 12 b.)

Polypary unilateral, compound, monopronidian. Principal branch long, slender, and elegantly recurved, originating similar simple (or compound?) secondary branches at very distant intervals. Hydrothecæ twenty to twenty-five to the inch, adnate in contact only, proximally subtriangular, mucronate; distally tubular, with slightly expanded and more or less everted denticulate apertural margin.

The branches of this species are about one twentieth of an inch in transverse diameter, if we include the projection of the hydrothecæ; and they all exhibit the elegant convex curvature characteristic of the genus. They remain of the same general diameter of one twentieth of an inch throughout their whole extent, which, in the longest specimens in my collection, is about 3 inches.

The first branch is given off invariably between the fifth and sixth hydrothecæ, counting from the sicula, the second branch about half an inch beyond. Both imitate the main branch in the direction and amount of their curvature.

The hydrothecæ on the proximal portion of the main branch remind one at first glance of those significant of the Monograptidæ typified by *Monograptus Sedgwickii* (Portlk.). In reality, however, they are of the same general type as those in the main body of the fossil; they are tubular and adnate, but have their expanded distal extremities abnormally everted and produced.

The hydrothecæ on the branches and the distal portion of the main stem are narrow tubes, inclined at a very steep angle to the axis of the polypary, and very slightly, if at all, expanding towards the aperture. Their distal extremity, however, is very suddenly expanded immediately at the aperture, which is distinctly everted, so that the apertural margin makes more than a right angle with the axis of the branch. The resultant denticle is very acute, and is occasionally prolonged into a minute spine directed obliquely. The sudden distal expansion of the theca gives an appearance of constriction below the denticle which is very characteristic.

*Cyrtograptus Linnarssoni* differs from *C. Murchisoni*, Carr., in the greater tenuity of the branches, in their much rarer subdivision, and most especially in the form and proportions of the adult hydrothecæ. Baily's figure of his *Didymograptus* (*Cyrtograptus*) *hamatus* reminds us of the young of the present species; but in his form there are at least eight proximal hydrothecæ, while the distal hydrothecæ are of the type of those of *M. Nilssoni*, Barr., and more like those of *Cyrtograptus Carruthersi*, Lapw.

I name this well-marked species after Mr. G. Linnarsson, the eminent palæontologist to the Swedish survey, to whom all palæontologists owe a debt of gratitude for his minute and accurate memoirs on Swedish palæontology.

*Horizon and Locality.* *Cyrtograptus Linnarssoni* is met with in some abundance in the Wenlock shales of the neighbourhood of Builth, Radnorshire. I have collected a few fragments in the Wenlock shales of Presteign and the vale of the Onny, above Horderly, Shropshire.

#### Family Leptograptidæ.

##### 14. *Azygograptus cælebs*, sp. nov. (Pl. V. figs. 16 a-16 c.)

Polypary unilateral, monopronidian, consisting of a single, simple and very slender, slightly recurved stem a few inches in length, proceeding from the major extremity of a well-marked sicula. Hydrothecæ twenty-five to the inch, in contact only, expanding slightly in the direction of the aperture, which is acute, straight, and facing slightly inwards; outer margin slightly convex; denticle blunt, a little everted.

This species is known to me only in the form of a few fragments from the Upper Skiddaw slates of Ellergill, Cumberland, where it was collected by myself in 1874. One example only shows the sicular extremity; but this is beautifully preserved and exhibits the generic and specific characteristics of the form most distinctly. The longest fragment is about two inches in length. In the sicular fragment the hydrothecæ, which are preserved as casts, distinctly overlap each other for a very short distance. In the compressed examples they appear to be wholly free, and have the general characteristics of those of *Leptograptus* and its allies. They expand more rapidly in the direction of the aperture than in *Leptograptus*; but this is a feature which *Azygograptus* shares with *Cænograptus* and, indeed, all the earlier forms of the Leptograptidæ. There is some evidence of the usual faint

excavation opposite the thecal aperture ; but it is hardly to be detected under the microscope. The apertural margin wants the concavity invariably seen in the *Dichograptidæ*, and is either straight or somewhat convex.

*Horizon and Locality.* Upper Skiddaw slates of Ellergill, Cumberland.

### Family *Dicranograptidæ*.

#### 15. *Dicellograptus complanatus*, sp. nov. (Pl. V. figs. 17 a-17 c.)

Branches of polypary usually straight, diverging from each other at a wide angle ; proximal portion short and straight, with a well-marked radicle and a rudimentary axillary spine. Hydrothecæ twenty to the inch, about as long as the width of the polypary, of equal diameter throughout ; apertures perpendicular to the axis of the theca, slightly concave, opening within a shallow well-marked excavation.

The branches of the polypary have a width of about one fortieth of an inch at their origin, and gradually augment their diameter till a breadth of one twentieth of an inch is attained. They are of great length and generally straight. Occasionally, however, they bend slightly outwards throughout the whole of their extent.

The axillary portion of the polypary is formed by the sicula and the two primary hydrothecæ. It is about one twelfth of an inch in extent, and a little rounded proximally. A well-marked radicle is invariably present, but no distinct lateral spines ; and the axillary prolongation of the sicula is short and blunt, and not always visible.

The branches diverge from the axil at an angle of from 90° to 120°.

The hydrothecæ are precisely similar to those in the genus *Climacograptus* (Hall). They are short rounded tubes, without overlap, placed parallel with the axis of the polypary. No portion of the length of the theca is isolated ; nor is there any distinct appearance of the distal introversion so characteristic of *Dicellograptus elegans* (Carr.) and its allies. The aperture opens interior to the ventral margin of the branch, perpendicular to its general direction, within a small excavation in the base of the succeeding hydrotheca.

The nearest ally of the present species is *Dicellograptus Forchhammeri*, Geinitz, which differs from it in the characteristics of its axillary portion, and in the striking introversion of the distal extremity of the theca.

*Dicellograptus complanatus* appears to be confined to a single horizon in the Moffat series. It occurs in extraordinary abundance in a thin seam of dark shales near the base of the "Barren mudstone" of the Upper Hartfell shales at Dobb's Linn, Moory Syke, &c. It is met with upon the same horizon near Portpatrick, and swarms abundantly in the corresponding zone in the Hartfell shales of county Down (*Swanston*), and in the equivalent Myoch-Bay beds of the Bala rocks of the neighbourhood of Girvan.

16. *Dicellograptus intortus*, sp. nov.  
(Pl. V. figs. 19a-19c.)

Branches of polypary slender and gently curved, diverging from each other at a very small angle. Axil pointed, provided with a strong radicle, but destitute of both sicular and lateral spines. Hydrothecæ twenty-four to twenty-eight to the inch, free for one third to one half their length; free portion strongly introverted, opening within a deep and very oblique excavation.

The branches of the polypary in this species rarely exceed one fortieth of an inch in average diameter; they diverge from each other at an original angle of about  $30^{\circ}$ , and gradually curve round in such a manner as to become first parallel, then crossing. The point where they cross each other lies generally within an inch or an inch and a half from the initial extremity of the polypary. Many examples, however, show no tendency to a crossing of the branches, but retain their original angle of divergence throughout the whole of their extent, which rarely surpasses three inches.

The axil in this form is narrower than in any other species of *Dicellograptus* yet described. There is no trace of a sicular spine, and very rarely of lateral spurs. A well-marked radicle is invariably present.

The hydrothecæ are of the general type of those in *Dicellograptus elegans* (Carr.). They are short and stout, and the free portion is strongly introverted. The excavation is rarely discernible, being so completely filled by the introverted theca, that even on the best-preserved examples it is only visible as a very oblique slit traversing a large fraction of the width of the polypary.

This species has some little resemblance to *Dicellograptus caduceus*, Lapw., in its general appearance. The form of the axil and its ornaments and the characteristics of the hydrothecæ, however, are very distinctive.

*Horizon and Locality.* *Dicellograptus intortus* occurs in

abundance in the highest zones of the *Glenkiln shales* at Glenkiln, Dobb's Linn, Carnalea (Ireland), and in the higher Llandeilo rocks of Builth, at Wellfield, and near Builth-road station.

17. *Dicellograptus patulosus*, sp. nov.  
(Pl. V. figs. 18 a-18 f.)

Branches of polypary stout and slightly curved, diverging from each other at a wide angle. Axil short, rounded, or obtusely angular; axillary spine stout, oblique, often invisible; radicle well marked; lateral spines rudimentary, rarely visible. Hydrothecæ twenty to twenty-two to the inch, free for a small fraction of their length; distal portion contracted; aperture very oblique, opening partly within a distinct excavation in the base of the succeeding hydrotheca.

In the majority of examples of the typical form of this species the axillary portion is bluntly triangular in form, the two primary hydrothecæ being directed slightly backwards. The proximal extremity is always provided with a well-marked radicle; but the lateral spines are only very rarely distinguishable, and are always very rudimentary. The sicular spine varies much in length, and is very frequently invisible altogether. When present it is generally stout and pointed; it hardly ever occupies its normal position with respect to the dorsal angle of the branches, but inclines to one side and is occasionally united to the nearest branch by a distinct membranous film.

The hydrothecæ differ essentially from those characteristic of the majority of the *Dicellograpti* in the fact that the distal portion is not free and protuberant, with introverted extremity, but is rather narrowed distally, and the aperture alone is oblique and directed inwards. A very small fraction only of the apertural margin lies outside the line of the ventral edge of the polypary; and hence the polypiferous border has a very smooth appearance. The excavation is somewhat triangular in form, and occupies from one fourth to one sixth of the ventral margin.

*Dicellograptus patulosus* differs from *D. Forchhammeri* in the form of the axillary portion of the polypary, in the absence of freedom and introversion of the distal fraction of the hydrothecæ, &c. From all other species its general habit is sufficient to distinguish it.

*Horizon and Locality.* Occurs in great numbers in a single zone in the Glenkiln shales at Glenkiln, Craigmichan, Dobb's Linn, &c.



18. *Dicellograptus divaricatus*, Hall, var. *rigidus*, Lapw.  
(Pl. V. figs. 20 a, 20 b.)

*Dicellograptus moffatensis*, var. *divaricatus*, Hall, Lapworth, Graptolites County Down, Proceedings Belfast Nat. Field-Club, 1876, pl. vii. fig. 10, &c.

Branches of polypary stout and rigid, divaricating at a medium angle. Axil narrow and deep, bluntly pointed proximally, frequently extended distally by a chitinous film uniting the dorsal surface of the earlier portions of the branches. Axillary spine, radicle, and lateral spurs rarely visible. Hydrothecæ twenty-four to the inch, short, free for about one third of their length; free portion of each so strongly introverted that the ventral margin of the branch appears unbroken.

The branches in typical examples of this form are tolerably straight, and are of an equal width of about one sixteenth of an inch throughout. They diverge at an average angle of about 60°. In a few examples there is a well-marked outward curve within a short distance of the axil; and this is occasionally succeeded by a general inward curvature of long radius.

As a rule the axillary portion of the polypary forms a small triangle. There is frequently a short radicle; but only in very young forms is there a trace of either axillary spine or lateral spurs. A thick web of chitinous matter unites the dorsal edges of the two branches as far as a point opposite the aperture of the third hydrotheca.

The vast majority of specimens afford no trace of the presence of hydrothecæ beyond a slight crenulation of the ventral margin of the branch, both ventral and dorsal edges appearing equally smooth and unbroken. This may be called the characteristic aspect of the species. In the opposite or obverse aspect the form and position of the thecæ can often be made out with certainty. They agree very closely with those in *Dicellograptus intortus*, the free portion of each being strongly introverted, while the apertural margin is inclined, and opens wholly within the ventral margin. It is pressed so closely against the base of the succeeding theca that the excavation is only discernible as a faint slit running obliquely across the body of the polypary.

This is the form I have generally referred to Hall's *Graptolithus divaricatus* (Grapt. Quebec Group, p. 14, fig. 14, upper figure). It is the only British form known to myself that can be even with doubt referred to his species. If his figure is correctly drawn, however, the British and American forms must be dis-

tinct. Hall's second figure belongs clearly to a different species—one representative, it may be, of *Dicellograptus patulosus*.

### Family Dichograptidæ.

#### BRYOGRAPTUS, gen. nov.

Polypary bilaterally subsymmetrical, consisting of two compound monopronidial branches diverging at a small angle from a well-marked sicula, and originating similar compound (or simple?) secondary branches at close but irregular intervals from one margin only. Hydrothecæ minute, of the type of those of *Dichograptus*, Salt.

This genus differs from *Dichograptus* and *Clonograptus* mainly in the fact that the secondary and tertiary branches are given off at irregular intervals, while the two chief branches, instead of proceeding outwards in opposite directions, make but a small angle with each other, composing an irregular polypary of an irregular dendroid form. It is doubtful if this latter feature is of any great systematic importance, as both *Didymograpti* and *Tetragrapti* of slightly divergent type are known. Nevertheless the habit of the two Cambrian species here united under this title is so distinctive that they may well be provisionally separated from *Dichograptus* until they are more perfectly known. Only two forms have yet been met with. The first is figured in Kjerulf's 'Veiviser,' published at Christiania in 1865. The second was collected by Dr. Callaway in the Shineton Shales of Shropshire in 1873. They are here noticed because of their geological importance, being the oldest forms of *Graptolithus* hitherto detected.

#### 19. *Bryograptus Kjerulfi*, sp. nov. (Pl. V. figs. 22 *a*, 22 *b*.)

*Graptolithus tenuis*, Portlock, Kjerulf, Veiviser, p. 3, figs. 6, *a*, *b*, A, B.

Polypary consisting of two very slender primary branches diverging from a well-marked sicula at an angle of about 40°, and giving origin to two (or more) compound secondary branches at close intervals from their inner margin. Hydrothecæ eighteen to twenty-four to the inch.

The above description is drawn up from Kjerulf's figures (*a* and *b*). If the figures can be depended upon, the habit of the species is so unique that there can be no doubt of its distinctness from any species of the Dichograptidæ hitherto

described. His figure *c* may be intended for the same species. It is less intelligible, however, and points rather in the direction of *Clonograptus*.

*Horizon and Locality.* Etage 2. Alum Slates of Vakkerö, near Christiania. Named after Professor Kjerulf, of the University of Christiania, who was the first to figure this form.

20. *Bryograptus Callavei*, sp. nov.  
(Pl. V. figs. 21 *a*, 21 *b*.)

Polypary consisting of two slender primary branches diverging from each other at a small angle, and originating similar (compound?) secondary branches at irregular but short distances upon the inner margin. Hydrothecæ about twenty to the inch, long and slender, with acuminate denticle, of the general type of those of *Dichograptus*.

I give this title to several fragments of a species of *Bryograptus* placed in my hands for identification by Dr. C. Callaway, with others collected by himself in the Shineton Shales (Upper Cambrian) of Salop. Its close resemblance to the species described from the corresponding Norwegian beds is apparent at a glance; and the small angle of divergence of the branchlets in all the fragments known gives colour to the view of the generic identity of these species and their common distinctness from *Clonograptus*, Hall.

I dedicate it to Dr. C. Callaway, whose numerous and valuable contributions to Proterozoic and Archæan geology are well known.

*Horizon and Locality.* Shineton Shales of Cound Brook, Shropshire (Upper Cambrian).

Family **Diplograptidæ.**

21. *Diplograptus physophora*, Nicholson.  
(Pl. V. figs. 26 *a*, 26 *b*.)

*Diplograptus physophora*, Nicholson, Ann. & Mag. Nat. Hist. vol. i. ser. 4, pl. iii. fig. 7.

I give two figures illustrative of this very beautiful species, the distinctness of which has been doubted by some palæontologists. It occurs in great numbers and in excellent preservation in a single zone in the Birkhill Shales of South Scotland, always with the same superficial characteristics; so that the validity of the species is now beyond question. As it is mainly of interest from a zoological point of view, I shall defer its description till a future occasion.

22. *Diplograptus socialis*, Lapw., sp. nov.  
(Pl. IV. figs. 13 a-13 e.)

Polypary short and stout, about one fourth of an inch in length, with a maximum diameter of one twelfth of an inch; proximal spines minute, divergent, conspicuous; virgula capillary, slightly prolonged distally. Hydrothecæ thirty to thirty-two to the inch, inclined at an angle of  $45^\circ$ , tubular in form, without overlap; outer margin of each convex, with well-marked proximal excavation; aperture horizontal or oblique, concave, unornamented. Test transversely striated.

The features noted above are characteristic of a highly prolific little *Diplograptus* which everywhere accompanies *Dicellograptus complanatus*, Lapw., in its extended geographical range in Scotland and Ireland. The Irish specimens sent me by my friend Mr. Swanston, of Belfast, are in an excellent state of preservation, and show the superficial striation most distinctly. On the obverse aspect of the polypary there is a trace of a longitudinal septum, slightly undulating. On the reverse aspect no trace of a longitudinal seam is perceptible, the test of the fossil is unbroken and continuous from side to side. The virgula, as a rule, is just perceptible, projecting slightly beyond the distal margin of the polypary.

From *Diplograptus truncatus*, Lapw., its most intimately, this form is easily separated by its diminutive size, the prolongation of the virgula, and some distinctions in the shape of the hydrothecæ.

*Horizon and Locality.* *D. socialis* occurs in countless numbers in the dark seam at the base of the "Barren Mudstone" of the Moffat series at Dobb's Linn and elsewhere, upon the same horizon at Coalpit Bay, Ireland, and at Shalloch Mill &c. in the Girvan district of Ayrshire.

23. *Diplograptus* (*Glyptograptus*) *euglyphus*, sp. nov.  
(Pl. IV. figs. 14 a-14 e.)

*Diplograptus dentatus*, Brongn. Lapworth, Trans. Belfast Nat. Field-Club, 1856-7, pl. vi. fig. 13; Quart. Journ. Geol. Soc. 1878; Ann. & Mag. Nat. Hist. 1879, iv. p. 424.

Polypary diprionidian, with parallel margins, from one to four inches in length, and with an average diameter of one twelfth of an inch; proximal end rounded, furnished with a minute radicle, but destitute of lateral spines. Virgula conspicuous, distally prolonged. Hydrothecæ eighteen to twenty-four to the inch, inclined at an angle of about  $40^\circ$ ; short, free tubes, with convex outer edge, and deeply concave apertural margin.

Few of the specimens of this form exceed an inch and a half in extent; but occasionally a group of gigantic examples are met with three or four inches in length. The margins are perfectly parallel throughout, except near the proximal extremity, which is rounded off and provided with a short radicle only. In the generality of examples the virgula is prolonged distally to an extent almost equal to that of the polypary itself. The hydrothecæ are of the form of those of *Diplograptus tamariscus*, Nich. (the type of the subgenus *Glyptograptus*). They are rounded tubes, approximately of the same diameter throughout, and divided from each other by a non-polypiferous internode equal to their own length. They are arranged in alternating order on a polypary of concavo-convex (?) section, with no visible septum upon the reverse aspect, but with a thick continuous test, which is strongly striated transversely.

This species differs from the Arenig form referred by authors to Brongniart's *Diplograptus dentatus* (to which I formerly assigned it) in several important points of structure. In some good examples of that form, lately procured by myself from the Arenig beds of Shelve, the thecæ overlap for half their length, their edges are undulating, and the proximal extremity of the polypary is provided with three spines.

*Horizon and Locality.* *Diplograptus euglyphus* is rare in the Glenkiln Shales of Dobb's Linn, Craighmichan, Hartfell, &c., but very common in the Glenkiln beds of Birnock, Cairn Hill, &c. in the Leadhills district.

#### 24. *Diplograptus perexcavatus*, Lapw.

*Climacograptus perexcavatus*, Lapworth, Trans. Belfast Nat. Field-Club, 1877, pl. vi. figs. 35, *a*, *b*.

*Diplograptus angustifolius*, Hall, Lapworth, *ibid.* figs. 1, *a*, *b*.

In the Glenkiln and Lower Hartfell Shales of the south of Scotland one of the commonest fossils is the diprionidian Graptolite named above. I have hitherto ranged it indifferently in *Climacograptus* and *Diplograptus*, from the circumstance that it exhibits the distinct characteristics of these genera combined in one and the same polypary. I have recently collected several examples of this form in partial relief. The evidences they afford of its general structure permit us to remove it from *Climacograptus*, and to range it definitely under *Diplograptus*, from the type forms of which, however, it differs so greatly that it ought probably to form the type of a distinct subgenus.

In the obverse aspect (Pl. V. figs. 25 *b*, 25 *c*, 25 *d*) the hydrothecæ show all the characteristic features of those of

*Climacograptus*, the subperpendicular margin and deep excavation. In the reverse aspect (figs. 25 *e*, 25 *f*) the thecæ are those of *Diplograptus*, with long inclined subparallel walls and oblique apertural margin; while the central part of the polypary appears similarly destitute of the longitudinal septum. In the obverse aspect of the examples presented in relief, or but slightly compressed, the under wall of each hydrotheca is continued in a deeply impressed line, which crosses the face of the polypary obliquely till it meets with a similar line derived from the corresponding hydrotheca of the opposite series (figs. 25 *a*, 25 *b*–25 *d*). Thus the base of each hydrotheca appears to rest upon the lower half of the upper wall of its opposite neighbour. A longitudinal septal line formed by the deep groove between these opposed hydrothecæ runs in short zigzag curves down the middle third of the polypary, as in *Idiograptus* and in the Retiolitidæ generally.

The American species *Diplograptus amplexicaulis*, Hall (Pal. New York, vol. i.), clearly belongs to the same subgroup. It differs from the present form chiefly in the greater length and tenuity of the polypary, and in the form of the distal portions of the hydrothecæ. (See Hall, 20th Report State Cabinet, 1867, pl. iii. figs. 6 & 7.)

*Diplograptus perexcavatus* is a common fossil in the Glenkiln beds of Scotland and Ireland, and in the Upper Llandeilo strata of Llandrindod Wells, Radnorshire.

### 25. *Diplograptus rugosus*, Emmons?

*Diplograptus rugosus*, Emmons, American Geology, pl. i. fig. 26.

*Diplograptus laciniatus*, Emmons, *ibid.* fig. 24.

*Diplograptus* (*Graptolithus*) *pristis*, Hall, Pal. New York, vol. i. pl. 72. fig. 1, *o*, &c.

*Diplograptus hypniformis*, White, Geol. Rep. 100th Meridian.

Polypary diprionidian, one to two inches in length, margins parallel distally, but tapering proximally from an average diameter of about one eighth of an inch to a blunt initial extremity, which is invariably provided with a well-marked radicle and lateral spines. Virgula stout, prolonged distally. Hydrothecæ twenty-four to twenty-eight to the inch, short stout tubes, inclined at an angle of about 40°, slightly overlapping, deeply excavated; apertural margin straight or concave, usually greatly inclined; denticle acute. Test striated.

The peculiarities of the hydrothecæ constitute the most pronounced characteristic of this species. In the living state they were probably short stout tubes, slightly overlapping, and greatly narrowed transversely, but with a broad expanded aperture. In the profile view they are seen to be flattened

in their middle portion over the mouth of the preceding theca, while the apertural portion is wide and patulous. The specimens preserved in partial relief show that the thecal walls of each series are prolonged in a distinct groove into the central portion of the polypary, as in the last-mentioned species; so that in casts the impressions of the thecæ present the imbricated or amplexicaul arrangement so marked in *D. perexcavatus* and *D. amplexicaulis*.

This form is frequently confounded with *Diplograptus foliaceus*, Murch., from which it differs (*a*) in the smaller inclination of the hydrothecæ, (*b*) their greater distal expansion and (*c*) imbricate arrangement, and (*d*) in the shape and prolongation of the apertural margin.

I have provisionally referred it to *Diplograptus rugosus*, Emmons, which was the earliest described example of the American species figured under the references given above. Of the specific identity of all these forms it is as yet impossible to speak with certainty; but those figured can all be paralleled by Girvan examples of the form under description.

*Horizon and Locality.* *Diplograptus rugosus* is a very common form in the Lower Girvan rocks (Bala) of Laggan, Ardmillan, Penwhapple, Piedmont Glen, &c. Examples doubtfully referable to the same species have been collected by myself from St. Clears and other Welsh localities.

26. *Climacograptus confertus*, Lapw.  
(Pl. IV. figs. 15 *a*, 15 *b*, 15 *c*.)

*Climacograptus confertus*, Lapworth, Quart. Journ. Geol. Soc. 1875, pl. xxxiv. figs. 4 *a-f*.

This species has been already figured and described; but, owing to the absence of perfect specimens, the original drawing and diagnosis were very imperfect. The figures given in the present plate are drawn from more complete specimens recently collected by myself from the Lower Llandeilo beds of the neighbourhood of Llan Mill, near Whitland. The lateral spines characteristic of *C. calatus* are not present in this form. There is a distinct distal prolongation of the virgula.

*C. confertus* is closely allied to the species *C. calatus*, Lapw., and ranges apparently from the Upper Arenig to the summit of the Llandeilo formation.

IDIAGRAPTUS, subgen. nov.

Polypary diprionidian, with concavo-convex section, zigzag septum, and subcentral, filiform, direct virgula. Hydrothecæ consisting of alternate overlapping flattened prisms, contract-

ing towards a rectangular aperture, which is furnished with two distinct thecal spines. Periderm continuous, of great tenuity, apparently strengthened by an outline skeleton of strong chitinous threads.

The above title is proposed for a group of spinose diprionid Graptolitidæ that differ in several marked respects from *Diplograptus foliaceus* (Murch.) and its allies. They resemble *Lasiograptus* and the Retiolitidæ in the great tenuity of the periderm, and in the fact that when the latter is indifferently preserved, as is frequently the case, all that remains of the fossil is an outline of chitinous threads, giving it all the appearance of a skeleton *Retiolites*. The section of the polypary appears to have been concavo-convex; and in the normal view the two series of hydrothecæ are seen to have their bases in contact, as in *Retiolites* and *Lasiograptus*, a strong separating chitinous thread marking the place of the zigzag septum. In both the species known the aperture is provided with two spines, which proceed from the sinuses of the quadrangular orifice, and have a somewhat ascending direction. This sub-genus points in the direction of *Hallograptus*, Carruthers, MS. (of which *Diplograptus* (*Hallograptus*) *bimucronatus*, Nich., may be regarded as the type), but differs from it most distinctly in the absence of the scopulate reproductive processes which mark the gonosome in that genus. Hall figures a form, which he refers to his *Diplograptus* (*Idiograptus*) *Whitfieldi*, with scopulæ (Grapt. Quebec Group, pl. v. figs. 6-10); but this form is clearly distinct from his original *D. Whitfieldii* (Pal. New York, vol. iii. fig. 516), and is, I doubt not, a true *Hallograptus*.

27. *Idiograptus* (*Diplograptus*) *aculeatus*, sp. nov.  
(Pl. VI. figs. 23 a-23 f.)

Polypary about one inch in length, gradually augmenting in diameter, from a triangular proximal extremity to a maximum width of about one twelfth of an inch. Virgula distally prolonged. Hydrothecæ twenty-four to twenty-eight to the inch, alternately arranged, and provided with well-marked, slightly ascending, apertural spines.

The bluntly triangular proximal extremity of the polypary in this species is destitute of any extraneous ornamentation beyond the normal apertural spines of the primary hydrothecæ, which hardly exceed their ordinary length. The distal extremity of the polypary is formed by the final thecæ, and shows four distinct spines projecting from its angles. The virgula is filiform and straight, and is prolonged for a distance equal to about half the length of the polypary itself. There



is usually a gradual increment in width from the initial extremity of the polypary to its distal termination; but occasionally the margins in the distal moiety are perfectly parallel.

The test is of great tenuity, and is frequently invisible; an outline only of the angles of the fossil is preserved in strong chitinous threads. The zigzag septal line seems to be formed of a single thread of this nature, apparently of no greater thickness than that which outlines the hydrothecæ. The apertural spines occasionally attain a length equal to three fourths of the diameter of the polypary itself, and have almost invariably an upward direction.

This species is most intimately allied to the Glenkiln form I have usually referred to *Diplograptus* (*Idiograptus*) *Whitfieldii* (Hall). In that species, however, the thecæ are more distant, and the virgula is greatly prolonged, both proximally and distally. (Comp. Lapworth, Graptolites County Down, Proc. Belfast Nat. Field-Club, 1876-7, pl. vi. fig. 21.)

*Horizon and Locality.* Common in a single zone in the Middle Bala beds of Girvan at Shalloch Mill &c. Rare in the Hartfell Shales upon the same horizon at Syart Law, Dobb's Linn, &c.

28. *Diplograptus* (*Cyrtograptus*) *tricornis*, Carr.  
(Pl. V. figs. 27 a-27 e.)

In 1858 Mr. W. Carruthers, F.R.S., described and figured a remarkable diprionidian Graptolite from the Moffat Shales of Hartfell Spa, under the title of *Diplograpsus tricornis* (Carruthers, Trans. Roy. Phys. Soc. Edinb. 1858, p. 468, fig. 2). The chief feature relied upon by its founder as affording conclusive evidence of its distinctness from its frequent associate *Diplograptus foliaceus*, Murch., was the presence of three strong spines at the proximal extremity of the polypary, the central spine being perpendicular, and the two side spines approximately horizontal. The illustrative figure, however, shows a far more remarkable peculiarity; the hydrothecæ are exhibited as rhomboidal in form, in contact throughout the whole of their extent, their bases resting upon the septal line, and their apertures (?) forming a continuous and slightly undulating line along the ventral margin of the polypary.

The following year Professor Hall gave a diagnosis and figure of an American species from the Hudson-River group under the title of *Graptolithus marcidus* (Hall, Pal. New York, iii. p. 515, figs. 1-3). Like Mr. Carruthers's species, this new form was provided proximally with two horizontal

spurs, visible only in the ventral aspect, while both the lateral margins were wrinkled or undulated in the profile view. Professor Hall can hardly be said to have attempted the description of the shape of the hydrothecæ in *G. marcidus*, but rather to have contented himself with noting the form and position of the marginal serratures. A glance at one of his figures (fig. 2) shows some most remarkable features in his fossil, not only difficult of reconciliation with his description, but totally at variance with the view generally held of the structure of the polypary in the genus *Diplograptus*. The marginal denticles in the specimen figured, instead of being directed acutely upwards as in other forms of the diprionidian Rhabdophora, project obliquely downwards, in the direction of the proximal extremity of the polypary. If, therefore, they stand to the individual hydrothecæ from which they are derived in corresponding relations to those in the generality of diprionidian forms, they must be inverted in position—their apertures, instead of opening towards the distal end of the polypary, must be turned proximally in the direction of the initial extremity of the polypary.

In 1868 we find Mr. W. Carruthers claiming the American form as being identical with his previously described *Diplograptus tricornis* (Geol. Mag. 1868, p. 131); and many graptolithologists have subsequently supported this view.

In 1872 Mr. John Hopkinson described and figured a form of *Diplograptus* from the Moffat Shales of Wenlockhead, under the name of *Diplograptus Etheridgii* (Geol. Mag. 1872, p. 504), which appears to possess the essential characteristics of *Diplograptus tricornis*, Carr., and to be very doubtfully separable from that species. At first glance, however, it would appear that the hydrothecæ in the two forms are strikingly distinct in shape. Instead of being rhomboidal, as in *D. tricornis*, the thecæ in *D. Etheridgii* are described as having “the appearance of rounded knobs, their outer margins forming a continuous curve, at first concave, and then, for about half their length and round their apertures, convex.”

That these three forms, if not specifically identical, are, at any rate, most intimately allied, I have long been convinced; but I have hitherto been baffled in my endeavours to show that appearances so diverse as those noted above can possibly be presented by one and the same diprionidian form. Fortunately, however, I have very recently collected a large series of specimens of a dwarf variety of *D. tricornis* from the Lower Bala rocks of Girvan, preserved in partial relief. A careful microscopic study of these specimens has enabled me to gain a tolerably complete idea of the uncompressed form of

the polypary, and of the appearances which are naturally presented by it when compressed in different directions.

In the ventral aspect the appearance of the polypary is (as shown by Carruthers and Hall) precisely similar to that in *Climacograptus*, except that the apertures, instead of being semicircular in form, are subrectangular. When the fossil is preserved in partial relief these apertures seem to occupy about two thirds of the ventral aspect; but a study of numerous examples proves that only the lower half of this vacant space is formed by the true aperture, the upper half being occupied by the fractured matrix filling a distinct "excavation" (see Pl. V. fig. 27 c). In profile views (figs. 27 b, 27 c) the characteristic form of the hydrotheca is well shown, and we see at a glance the cause of the appearance presented by such forms as Hopkinson's *D. Etheridgii*. The hydrothecæ have features common to those of both *Diplograptus* and *Climacograptus*. They are steeply inclined and have an oblique aperture, as in the former, while their apertural margin opens wholly within the ventral margin of the polypary, in a distinct excavation, as in the latter genus. In the obverse (?) aspect (fig. 27 e) their walls appear to be elegantly curved, and there is an appearance of distal expansion. In the reverse aspect the walls are almost straight, and the thecæ are of equal width throughout. These diverse appearances are, in all probability, a result of the original form of the polypary, which was somewhat concavo-convex previously to compression.

The outer portion of each hydrotheca forming the wrinkled-looking ventral margin of the polypary is composed of three divisions. The lowest division is a distinct excavation (visible directly only in subscalariform views) which overhangs the aperture of the theca immediately below. The outer sinus of this "excavation" is prolonged, as in many species of *Climacograptus*, into a mucronate extension, oblique, and occasionally of remarkable length. The middle division is short and approximately perpendicular, as in *Climacograptus*. The final division is formed by the line of the apertural margin. The latter is very oblique with respect to the axis of the polypary, but, as in the majority of other Diprionida, is almost at right angles to the normal direction of the hydrotheca. It lies wholly within the ventral boundary of the polypary, and is visible in very rare cases. As pointed out by Mr. Hopkinson, the test in these forms is of remarkable tenuity. It is generally preserved as a mere stain, very different from the stout chitinous film representing the commoner diprionidian forms with which it is usually associated. In

the Girvan examples the test appears to have been more or less punctate.

We are now in a position to harmonize the apparently conflicting appearances presented by the forms noticed at the commencement of this description, and to show that they may have all been derived from this single species. In Pl. V. fig. 27 *d* we see the rhomboidal theca and zigzag ventral margin presented in Carruthers's original figure of his *D. tricornis*. In the same figure the general aspect of the hydrothecæ is very similar to that given in Hopkinson's description of his *D. Etheridgii*; and the explanation of the rounded knob-like form of their distal extremities may be gathered from a study of fig. 27 *b*. The "inverted" denticles in Hall's *D. marcidus* are simply the compressed and prolonged oblique denticles that project from the outer sinus of the excavations.

The characteristics of this species are so unique that there can be little doubt that it is worthy of generic rank. In the general habit of the polypary, in the form of the hydrotheca, and in the punctate character of the test, it differs both from *Diplograptus* and *Climacograptus*. I would suggest for it the generic title of *Cryptograptus* (Gr. κρυπτός, concealed), in allusion to the intramarginal and usually concealed aperture of the hydrothecæ.

#### CRYPTOGRAPTUS, gen. nov.

*Gen. char.* Polypary diprionidian, with attenuated punctate test, subparallel margins, and concavo-convex (?) section. Hydrothecæ inclined; lower wall straight or slightly arcuate, outer third forming a distinct excavation, the upper sinus of which is mucronate and oblique; outer wall very short, perpendicular; aperture very oblique, lying wholly within the ventral margin of the polypary.

Type *Diplograptus* (*Cryptograptus*) *tricornis*, Carr.

Forms belonging to this genus are not uncommon in the Upper Arenig rocks of Skiddaw; and examples referred by myself to *D. tricornis* have been collected from the Lower Llandeilo strata of Pembrokeshire. The form figured in Pl. V. fig. 28 *a* occurs in remarkable abundance in the Upper Llandeilo beds of Radnor. *Cryptograptus tricornis* is very numerous in the Glenkiln and Lower Hartfell shales of the south of Scotland, together with the variety (?) *D. Etheridgii*, Hopk., and other forms. I strongly suspect that the Arenig species *Climacograptus antennarius*, Hall, and *Diplograptus Hopkinsoni*, Nich., belong to the same group. If so, the genus has already been recognized in America, Britain, and

Scandinavia, and its range must extend at least from the lowest beds of the Arenig formation to the middle strata of the Bala.

### Family *Lasiograptidæ*.

#### 29. *Lasiograptus retusus*, sp. nov. (Pl. V. figs. 24 a-24 d.)

Polypary about one inch in length, with a uniform diameter of one twelfth of an inch. Virgula capillary, distally prolonged. Septum zigzag. Hydrothecæ thirty-six to the inch, once and a half as long as broad, arranged alternately, each in contact with those of the opposite series for two thirds of its length; ventral edge very short and devoid of ornamentation; aperture broad, horizontal, opening within the ventral margin of the polypary; excavation triangular in form, occupying one third of the transverse diameter of the polypary and about two thirds of its ventral margin.

The polypary in this very distinct form possesses, in a marked degree, the essential characteristics of the genus *Lasiograptus*, with the exception of the marginal meshes (amentula), which are absent in the specimen figured. The zigzag septal line formed by the adpressed bases of the two opposed series of hydrothecæ is beautifully exhibited, and its distinctness in position from the virgula proper is placed beyond question by the straggling position of the ridge formed by the latter upon the exposed face of the polypary.

The hydrothecæ are very similar in form to those in *Lasiograptus Harknessi*, Nich. sp.; but the excavation is deeper and more conspicuous. Each theca is in contact with two of its nearest neighbours of the series on the opposite margin of the polypary, the median line of separation forming a very peculiar zigzag longitudinal seam on the face of the fossil. Each is subquadrangular in general form, and is inclined at an angle of about  $45^\circ$  with respect to the main axis. A deep excavation occupies at least two thirds of the ventral margin; the remaining third is perpendicular and shows a slight trace of ornamentation at the lower sinus. The aperture is horizontal or but slightly concave, and opens entirely within the succeeding excavation.

The species is easily separated from *Lasiograptus Harknessi*, Nich., and *L. margaritatus*, Lapw., by the general form of the polypary. Only two specimens have been collected; the gonosome or amentulate form is as yet unknown.

*Horizon and Locality.* Upper Llandeilo shales of the neighbourhood of Llandrindod Wells, Radnorshire.

## EXPLANATION OF THE PLATES.

## PLATE IV.

- Fig. 1.* *Monograptus leintwardinensis*, sp. nov. 1 *a*, 1 *b*, natural size; 1 *c*, proximal portion, magn. 5; 1 *d*, distal portion, magn. 5. Lower Ludlow, Leintwardine. Collection, Mr. J. Hopkinson, F.G.S.
- Fig. 2.* *M. Salweyi*, sp. nov. 2 *a*, distal portion, nat. size; 2 *b*, ditto, magn. Lower Ludlow, Elton Lane, Herefordshire. Collection, Mr. Hopkinson.
- Fig. 3.* *M. colonus*, Barrande. 3 *a*, 3 *b*, young examples, nat. size; 3 *c*, young example, magn.; 3 *d*, adult portion, magnified. Lower Ludlow, Vinnal Hill, &c.
- Fig. 4.* Ditto, after Barrande, Grapt. de Bohême, pl. ii. figs. 2, 3.
- Fig. 5.* *M. Ræmeri*, Barr. 5 *a*, 5 *b*, nat. size; 5 *c*, proximal portion, magn.; 5 *d*, distal portion, magn. Lower Ludlow, Adfertton, and Builth Bridge.
- Fig. 6.* *M. galaensis*, var. *basilicus*, var. nov. 6 *a*, adult portion, nat. size (the lower portion is an impression only); 6 *b*, ditto, magnified (Wenlock Shales, Wellfield, near Builth); 6 *c*, proximal portion (*M. serra*, Hopk. MS.), nat. size; 6 *d*, magn. Lower Ludlow, Elton Lane.
- Fig. 7.* *M. Hisingeri*, Carr., var. *nudus*. 7 *a*, 7 *c*, nat. size; 7 *b*, magn. Grieston Shales, Grieston Quarry, Innerleithen.
- Fig. 8 a.* *M. Flemingii*, Salter, nat. size. Wenlock Shale, Wellfield, near Builth.
- Fig. 8 b.* *M. crassus*, sp. nov., nat. size. Upper Birkhill Shales, Dobb's Linn, Dumfriesshire.
- Fig. 8 c.* *M. riccartonensis*, Lapworth, nat. size. Riccarton Beds, Elhiotsfield, near Hawick.
- Fig. 9 a.* *M. Halli*, Barrande (Graptolites de Bohême, pl. ii. fig. 12).
- Fig. 10.* *M. crenularis*, sp. nov. 10 *a*, distal portion, nat. size; 10 *b*, ditto, magn.; 10 *c*, distal portion (cast of), nat. size; 10 *d*, ditto, magn. Birkhill Shales, Dobb's Linn.
- Fig. 11.* *M. crenularis*, var. *a*. 11 *a*, nat. size; 11 *b*, 11 *c*, magn. Saugh-Hill beds, Girvan, Ayrshire.
- Fig. 12.* *Cyrtograptus Linnarssoni*, sp. nov. 12 *a*, nat. size; 12 *b*, magn. Wenlock Shale, Builth Road, Radnorshire.
- Fig. 13.* *Diplograptus socialis*, sp. nov. 13 *a*, 13 *b*, nat. size; 13 *c*, magn. Upper Hartfell Shales, Dobb's Linn.
- Fig. 14.* *D. euglyphus*, sp. nov. 14 *a*, nat. size; 14 *b*, magn.; 14 *c*, distal portion, nat. size; 14 *d*, proximal portion; 14 *e*, magn. Glenkiln Shales of Wanlockhead and Dobb's Linn.
- Fig. 15.* *Climacograptus confertus*, Lapworth. 15 *a*, proximal portion, magn.; 15 *b*, distal portion, profile view, magn.; 15 *c*, ditto, ventral aspect, magn. Lower Llandeilo of Llan Mill, near Narberth.

## PLATE V.

- Fig. 16.* *Azygograptus cœlebs*, sp. nov. 16 *a*, proximal portion; 16 *b*, ditto, magn.; 16 *c*, distal portion, nat. size. Upper Skiddaw Slates, Ellergill, Westmoreland.
- Fig. 17.* *Dicellograptus complanatus*, sp. nov. 17 *a*, 17 *b*, nat. size; 17 *c*, axillary portion, magn.; 17 *d*, 17 *e*, distal portion, magn. Upper Hartfell Shales, Dobb's Linn.
- Fig. 18.* *D. patulosus*, sp. nov. 18 *a*, 18 *b*, 18 *c*, natural size; 18 *d*, 18 *e*, proximal portion, magn.; 18 *f*, distal portion, magn. Upper Glenkiln Shales, Craigmichan and Glenkiln Burn.

- Fig. 19. *D. intortus*, sp. nov. 19 *a*, 19 *b*, nat. size; 19 *d*, proximal portion, magn. Glenkiln Shales, Glenkiln Burn and Wanlockhead.
- Fig. 20. *D. divaricatus*, Hall, sp., var. *rigidus*. 20 *a*, nat. size; 20 *b*, magn. Glenkiln Shales, Birnock Water, Leadhills district.
- Fig. 21. *Bryograptus Callavei*, sp. nov. 21 *a*, nat. size; 21 *b*, magn.; 21 *c*, branch, magn. Shineton Shales, Shineton, Salop. Collection, Dr. Callaway.
- Fig. 22. *B. Kjerulfi*, sp. nov. 22 *a*, nat. size; 22 *b*, magn. After Prof. Kjerulf (Veiviser, fig. 6, *a*, &c. p. 3).
- Fig. 23. *Diplograptus* (*Idiograptus*) *aculeatus*, sp. nov. 23 *a*, normal aspect, nat. size; 23 *d*, ditto, magn.; 23 *b*, 23 *c*, deprived of test, lateral views, nat. size; 23 *e*, 23 *f*, ditto, magn. Lower Girvan Rocks, Myoch Bay, Girvan, Ayrshire.
- Fig. 24. *Lasiograptus retusus*, sp. nov. 24 *a*, nat. size; 24 *b*, magn. 2; 24 *c*, distal portion, magn. 5; 24 *d*, proximal portion, magn. 5. Upper Llandeilo, Llandrindod Wells, Radnorshire.
- Fig. 25. *Diplograptus perexcavatus*, Lapworth. 25 *a*, complete, partly restored, nat. size; 25 *b*, 25 *c*, fragments in relief, nat. size; 25 *e*, proximal portion, magn.; 25 *d*, distal portion, magn., showing overlapping bases of the hydrothecæ; 25 *f*, ditto, magn. Lower Hartfell Shale (*Wilsoni* zone), Dobb's Linn.
- Fig. 26. *D. physophora*, Nicholson. 26 *a*, complete specimen, nat. size; 26 *b*, proximal portion, magn., showing form and mode of attachment of proximal "vesicle."
- Fig. 27. *Cryptograptus tricornis*, Carr., sp. 27 *a*, complete specimen, showing normal appearance of polypary (Hartfell Spa); 27 *c*, ventral aspect, magn. (the lower portion is an impression only); 27 *b*, reverse aspect, magn.; 27 *d*, ditto; 27 *e*, profile, partly restored, magn. Balclatchie beds, Laggan, near Girvan, Ayrshire.
- Fig. 28 *a*. *C. tricornis*, var. *Schæferi*: *a*, nat. size; *b*, proximal portion magn. Upper Llandeilo, Llandrindod Wells, Radnorshire.

XV.—On the Occurrence in North America of rare *Extinct Vertebrates found fragmentarily in England*.—No. 3. By Prof. R. OWEN, C.B., F.R.S., &c.

[Plate VIII.]

[Continued from ser. 5, vol. iv. p. 61.]

PART IV. SUPPLEMENTS TO RESTORATION OF *LEIODON ANCEPS*.

I HAVE been favoured by Prof. O. C. Marsh, of Yale College, New Haven, Mass., with a copy of his paper "On the new Characters of Mosasauroid Reptiles," based on an examination of "remains of not less than 1400 distinct individuals"\*. Knowing the riches of the Professor's collection, I have looked with much interest for the results of his examination as bearing upon and probably dissipating any remaining doubts as to the affinities and place in the Reptilian series of the huge

\* From the 'American Journal of Science,' vol. xix. (January 1880). p. 83.

extinct marine cold-blooded air-breathers typified by the *Mosasaurus Hoffmanni* of Conybeare and Cuvier.

At the date of the last two papers, quoted below\*, no evidence had been obtained, or been noticed in Prof. Cope's extensive illustrations of American Cretaceous Mosasauroids†, of a sternal bone or apparatus. This most important element in the question, as between the Ophidian and Lacertian nature of those reptiles, has been fully and satisfactorily demonstrated by the collection at Prof. Marsh's command; and as he thereby feels himself justified in inferring "the presence of a sternum in the entire group"‡, I do not hesitate in accepting this welcome addition to the complete restoration of our Leiodont modification of the Mosasaurian type; and I beg leave to offer such addition, with a few supplementary observations, to the paper admitted into 'Annals and Magazine of Natural History' for July 1879.

The following is Prof. Marsh's description of these long-missing parts of the skeleton:—

#### "THE STERNUM.

"The absence of a sternum has been asserted by Cope to be one of the important characters of the Mosasauroid Reptiles§; and this statement has been accepted by some authors||. Several specimens, however, in the Yale Museum, one of which is figured in plate i. fig. 1, prove the contrary." ... "The most perfect specimens of the Mosasauroid sternum preserved pertain to the genus *Edestosaurus*, and are of the true Lacertian type. The sternum in this genus is narrow and elongate in form, nearly or quite symmetrical, as shown in plate i. fig. 1 [st]. [This figure is given in Pl. VIII. fig. 1 of the present paper.] It is thin, slightly concave above and convex below. Its antero-lateral margins are short and rounded, and have distinct grooves for the coracoids. The costal margins are much longer and converge posteriorly. Each has facets for five sternal ribs; and, behind these, false ribs were supported by a partially ossified pedicle, which joined the end of the sternum. In the other genera of Mosa-

\* Quart. Journ. Geol. Soc. of London for November 1877, p. 682, and for August 1878, p. 748.

† 'The Vertebrata of the Cretaceous Formations of the West,' 4to, 1875. ‡ *Mem. cit.* p. 83.

§ 'Vertebrata of the Cretaceous,' p. 114 (1875); also 'Bulletin of Survey of Territories,' p. 309 (1878).

|| As the allegation rested on the somewhat treacherous basis of "non-finding" in commonly fragmentary and more or less incomplete skeletons represented by fossil remains, I limited myself to stating:—"Sternal or episternal elements of the scapular arch seem not to have been recognized in the American series of fossils" (*loc. cit.* p. 710, 1877).



sauroid reptiles the sternum has not yet been found so well preserved as in *Edestosaurus*; but there can be no reasonable doubt of its presence. In *Holosaurus* there appears to have been a partially ossified mesosternum"\*.

Thus to the restoration of *Leiodon anceps* in plate viii. of vol. iv. 5th series of the Annals and Magazine Nat. Hist., there may now be added not only the sternum, but also some pairs of sternal ribs.

A bone is described and figured as belonging to the hyoid arch†, of proportions rather Cetacean than Lacertian; it is still more remote, in form, from any hyoid element of the Ophidian type.

Sclerotic plates "like those in *Ichthyosaurus* and a few birds," forming a ring "composed of only a single row of plates, which, in position, overlapped each other"‡, further attest Saurian as against Ophidian affinities. I have accordingly added such circle of ossicles to the orbit in the restoration of *Leiodon* above cited.

When I prepared the paper on the affinities of the Mosasauroids (1877), the homologue of the ectopterygoid in Ophidia was not present in the specimens at my command, and had not been noticed in any of Prof. Cope's examples. I could only contrast with the palatal view of a Python's skull (ib. fig. 17) the mutilated portion of the same surface of the skull in *Mosasaurus Hoffmanni* (ib. fig. 16). The ectopterygoid has now been recognized by Prof. Marsh in three American genera of Mosasauroids (*Tylosaurus*, *Lestosaurus*, and *Edestosaurus*)§. In *Python* the ectopterygoid is a long, slender, narrow bone, having an oblique overlapping junction with the otherwise free hind end of the maxillary, and a similar but more extended junction with the outer surface of the middle expanded part of the pterygoid. In the Mosasauroids, as exemplified by *Tylosaurus*, the ectopterygoid "is an L-shaped bone, thin and somewhat twisted. One ramus unites by suture with the corresponding process of the pterygoid; and the other extends forward, nearly at a right angle, to join the maxillary"||.

In the paper on the affinities of the Mosasauroids, it was inferred from Prof. Cope's figures that the dentigerous palatal bones, which he determined to be the true "palatines," were the homologues of the bones described by Cuvier as the pterygoids in *Mosasaurus*¶. Prof. Marsh confirms this homology and consequent affinity to the Iguanidæ. Various specimens

\* Marsh, *ut supra*, p. 83. † *Ibid.* p. 85, fig. 1.

‡ *Ibid.* figs. 2, 3, 4 (*Lestosaurus simus*, Marsh).

§ *Ibid.* p. 86. || *Ibid.*

¶ Owen, Quart. Journ. Geol. Soc. 1877, p. 698.

in the Yale Museum show conclusively that the dentigerous bones of the palate in various genera of Mosasauroids were attached posteriorly to the tympanics and to the pterapophyses by ligament, to the maxillaries by the medium of the ectopterygoids, and to the true palatines by suture. "Cope has called these dentigerous bones 'palatines,' and has stated that they were separated from the quadrates by intervening bones\*; but on both points he was in error. The true palatines are small edentulous bones in front and outside of the pterygoids" †.

In regard to the vertebræ in Mosasauroids, the rich collection in "Yale Museum" does not appear to affect or add to the characters of the several divisions of the backbone, as defined by Cuvier and his successors, and as summarized in the 'Annals' for July 1879, p. 57, pl. viii. The best-preserved specimen of the vertebral column appears to be of an individual of the proportionally shortest form of Mosasauroid (*Holosaurus abruptus*, Marsh). This skeleton shows 98 vertebræ; but the tail is incomplete, and the preserved caudals are of the tenth type in the above "summary."

With the important additions to a knowledge of the framework of the pectoral arch and its appendages, Prof. Marsh has materials for the restoration of the bones of the fore fin in both *Edestosaurus* (Pl. VIII. fig. 1) and *Lestosaurus* (fig. 2). Neither of these genera supports the restoration figured by Prof. Snow in the *Leiodon* of the Kansas chalk ‡. They correspond more closely with that of a *Lestosaur* described and figured by Marsh in the 'American Journal of Science and Arts' for June 1872§. The digital formula in *Edestosaurus dispar* is I. 3, II. 5, III. 5, IV. 4, V. 3 (Pl. VIII. fig. 1)||. The same formula is repeated in the pectoral fin of *Lestosaurus simus* ¶. The fin is relatively broader in *Edestosaurus*; and in the specimen figured of *E. dispar* seven carpal bones (four in the proximal, three in the distal row) intervene between the five metacarpals and the two antibrachial bones. In the figured specimen of *Lestosaurus* (Pl. VIII. fig. 2) two carpals are shown at the ulnar end of the distal row, and the same number at the same part of the proximal row.

With regard to the antibrachial bones, I may observe that in the Crocodilia\*\*, the Lacertilia††, the Chelonii‡‡, and the

\* 'Vertebrata of the Cretaceous,' p. 118. † Marsh, *loc. cit.* p. 86.

‡ Copied in plate viii. fig. 13, of Ann. & Mag. Nat. Hist. for July 1879.

§ See also Owen "On the Affinities of the Mosasauridæ, as exemplified by the Bony Structure of the Fore Fin," Quart. Journ. Geol. Soc., August 1878.

|| Marsh, *loc. cit.* pl. i. fig. 1.

¶ *Ibid.* fig. 2.

\*\* Cuvier, Ossem. Foss. 4to, t. v. 2<sup>e</sup> partie, p. 111, pl. iv. fig. 13.

†† *Ibid.* pl. xvii. fig. 45.

‡‡ *Ibid.* pl. xii. figs. 11-15.

Sauropterygia\*, the ulna, <sup>55</sup>, is broader than the radius, <sup>54</sup> (Pl. VIII. fig. 1); and I would submit whether the antibrachial bones have not been transposed in Prof. Marsh's figures, and the ulna (marked *r*) placed at the radial side of the forearm. In the copy of his fig. 1, in Pl. VIII. fig. 1, I have indicated the several bones and digits by the symbols used in my 'Archetype of the Vertebrate Skeleton,' pl. i., as also in the figures 1-4 of the fore fin in the Quart. Journ. Geol. Soc. for August 1878, p. 749. In the copy of Prof. Marsh's fig. 2 in my Pl. VIII. I have transposed the position of the radius and ulna, agreeably with the analogies above referred to. To the restoration of the pelvic arch and appendages (Pl. VIII. fig. 3) I have nothing to object.

The sum of Prof. Marsh's observations on his rich series of American generic or subgeneric forms of Mosasaurians is as follows:—"The new characters above presented are all Lacertian rather than Ophidian. The important characters of the Mosasaurians now known indicate that they form a sub-order of the Lacertilia, which should be called *Mosasauria*"†. In this conclusion I entirely concur: it is that to which I was led after comparison of the evidences of the extinct group at my command in 1877 ‡.

#### EXPLANATION OF PLATE VIII.

- Fig. 1.* Sternum, scapular arch, and bones of the pectoral fins. (*Edestosaurus*.)  
*Fig. 2.* Bones of the pectoral fin, with Marsh's position of the antibrachial bones reversed. (*Lestosaurus*.)  
*Fig. 3.* Pelvic arch and bones of the pelvic fins. (*Lestosaurus*.)

#### PROCEEDINGS OF LEARNED SOCIETIES.

##### GEOLOGICAL SOCIETY.

November 19, 1879.—Henry Clifton Sorby, Esq., F.R.S.,  
 President, in the Chair.

The following communication was read:—

"Supplementary Note on the Vertebræ of *Ornithopsis*. Seeley (= *Eucamerotus*, Hulke)." By J. W. Hulke, Esq., F.R.S., F.G.S.

The author in this communication describes several cervical and trunk vertebræ of this remarkable Dinosaur. The former are cha-

\* 'Monograph on the Fossil Reptilia of the Liassic Formations.' 4to. In the Palæontographical volume, issued 1865, pl. i. *Plesiosaurus dolichodeirus*; pl. ix. *P. rostratus*; pl. xiv. fig. 4. *P. macrocephalus*, fig. 6. *P. Hawkinsii*.

† *Op. cit.* p. 87 (1880).

‡ *Loc. cit.*

racterized by great length; the anterior articular surface is strongly convex, and the posterior correspondingly hollow. In place of the side chamber characterizing the trunk-vertebral centra, is a long shallow pit. An upper and a lower transverse process are given off from an upper and a lower plate, which project from the side of the centrum above the pit; and these are connected by a short forked cervical riblet. The neural arch is dwarfed; and there is no spinous process, and no zygosphenal and zygantral mechanism. The structure of these vertebræ indicates a long, mobile, and light neck. In the trunk the convexity of the anterior articular surface lessens in passing from the neck to the loins, the anterior ball gradually subsiding till the great articular surface becomes plane, the posterior surface retaining, however, a slight hollowness. The trunk-vertebræ have superadded to the ordinary articular processes a mechanism comparable to zygosphenic and zygantrum, which must have given great fixity to this part of the vertebral column, contrasting strongly with the flexibility of the neck. The longitudinal side chambers reach their greatest development in the vertebræ referable to the fore part of the trunk; they lessen toward the loins, and are absent from the neck—which is regarded as conclusive of their pneumaticity, and against their having been occupied by cartilaginous and fatty tissues, which might have equally occurred through the whole length of the vertebral column, and not been limited to a particular region in close vicinity to the lungs. The whole construction affords a notable illustration of immense bulk attained with the use of the smallest quantity of bony tissue, which occurs in the form of very thin sheets or plates. The transverse and spinous processes are strengthened by flying buttresses. The vault of the neural canal is beautifully groined, whence the original name *Eucamerotus*. The author then pointed out the family resemblances between this Isle-of-Wight Wealden form and the new Colorado Dinosaurs, which have many points in common, but the latter are both generically and specifically distinct from *Ornithopsis*.

December 3, 1879.—Henry Clifton Sorby, Esq., F.R.S.,  
President, in the Chair.

The following communication was read:—

“On some undescribed *Comatulæ* from the British Secondary Rocks.” By P. Herbert Carpenter, M.A., Assistant Master at Eton College.

This communication contains descriptions of seven new *Comatulæ* from the Cretaceous and Oolitic series of Southern England, together with some new facts respecting the *Glenotremites paradoxus* of Goldfuss, from the Upper Chalk. This species is remarkable for the presence of certain characters which are very conspicuous in the recent *Antedon Eschrichtii*, and also in a new species dredged by the ‘Challenger’ at Heard Island in the South Atlantic—namely, the presence of strong ribs on the inner wall of the centrodorsal, five of

which, interradial in position, are much more prominent than the rest. So far as is yet known, these features occur in no other recent Comatula, with the exception of one species from the South Pacific, in which there is a faint indication of such ribs, but they are all equal. Another *Antedon*-species is described from the Chalk of Sussex. It differs from *Antedon paradoxa* in the absence of these ribs, and in the shallowness of the centrodorsal cavity.

Two species are described from the Gault of Folkestone. One is an *Antedon* with no special relations to any recent forms. It might have lived as well at 20 as at 500 fathoms. But the other species is an *Actinometra*, possessing certain characters only known to occur in species from quite shallow water, 20 fathoms or less, in the Philippine Islands and Malay archipelago. The centrodorsal is a flat plate, nearly on a level with the surface of the radials, or sometimes even below them, separated from them by clefts at its sides, and entirely devoid, not only of cirri, but also of cirrus-sockets. This condition is only an extreme stage of the metamorphosis of the centrodorsal piece, which bears cirri for a time after its liberation from the larval stem; but these cirri eventually disappear, and their sockets become obliterated. The 'Challenger' collection contains a series of specimens of *Act. Jukesii* from Torres Straits, which illustrate this point very completely; and it is therefore of no small interest to find a fossil Comatula which shows one of the extreme stages of the metamorphosis.

The large size of the three *Antedon*-species from the Chalk and Gault is very remarkable. *Ant. paradoxa* has a centrodorsal half as wide again as that of any recent form; while *Ant. Eschrichtii* is the only recent species with a centrodorsal approaching the size of those of the other Chalk *Antedon* and of that from the Gault. *Act. Lovéni* from the Gault, however, and the older Comatulæ, all had small calices like most recent species. An elegant centrodorsal (*Ant. rotunda*) is described from the Haldon Greensand, and also two species from the Bradford Clay. One is an *Antedon*, the oldest known, with no special characters; the other is an *Actinometra*, with a centrodorsal essentially like those of species now living in shallow water in the Philippines and Malay archipelago. The oldest known Comatula, an *Actinometra* from the Bath Oolite, has similar relations.

December 17, 1879.—Henry Clifton Sorby, Esq., LL.D., F.R.S.,  
President, in the Chair.

The following communications were read :—

1. "A Contribution to the Physical History of the Cretaceous Flints." By Surgeon-Major G. C. Wallich, M.D.

The author described the origin, the mode of formation, and the cause of the stratification of the Chalk flints. Taking as the basis of his conclusions the fact brought to notice by him in 1860, namely that the whole of the Protozoan life at the sea-bed is strictly limited

to the immediate surface-layer of the muddy deposits, he pointed out in detail the successive stages of the flint-formation, from the period when the chief portion of the silica of which they are composed was eliminated from the ocean-water by the deep-sea sponges, to the period when it became consolidated in layers or sheets conforming to the stratification of the Chalk. In relation to this subject the author claimed to have sustained the following conclusions:—1. That the silica of the flints is derived mainly from the sponge-beds and sponge-fields, which exist in immense profusion over the areas occupied by the Globigerine or calcareous “ooze.” 2. That the deep-sea sponges, with their environment of protoplasmic matter, constitute by far the most important and essential factors in the production and stratification of the flints. 3. That, whereas nearly the whole of the carbonate of lime, derived partly from Foraminifera and other organisms that have lived and died at the bottom, and partly from such as have subsided to the bottom only after death, goes to build up the calcareous stratum, nearly the whole of the silica, whether derived from the deep-sea sponges or from surface Protozoa, goes to form the flints. 4. That the sponges are the only really important contributors to the flint-formation that live and die at the sea-bed. 5. That the flints are just as much an organic product as the Chalk itself. 6. That the stratification of the flint is the immediate result of all sessile Protozoan life being confined to the superficial layer of the muddy deposits. 7. That the substance which received the name of “*Bathybius*,” and was declared to be an independent living Moneron, is, in reality, sponge-protoplasm. 8. That no valid *lithological* distinction exists between the Chalk and the calcareous mud of the Atlantic; and, *pro tanto*, therefore the calcareous mud may be, and in all probability is, “a continuation of the Chalk-formation.”

2. “Undescribed Fossil Carnivora from the Sivalik Hills, in the Collection of the British Museum.” By P. N. Bose, Esq., B.Sc.

This communication contained descriptions of nine species of Carnivora from the ossiferous Sivaliks, together with an introduction, in which the age of the Sivalik fauna, and several matters of general interest, were briefly discussed. The species described were:—*Machærodus sivalensis*, *M. palæindicus*, *Felis grandieristata*, *Hyæna sivalensis*, *H. felina*, *Viverra Bakerii*, *Lutra palæindica*, *Canis curvipalatus*, and *C. Cautleyi*.

*Canis curvipalatus* is so named on account of the curvature of the palate. *C. Cautleyi* is closely allied to the Wolf, as is *Viverra Bakerii* to the Civet. The form of the forehead is peculiar in *Lutra palæindica*. In the form of the skull, the dimensions of the upper tubercular, &c., *Hyæna sivalensis* approximates to the living Indian *Hyæna* (*H. striata*); but in the absence or extremely rudimentary character of the postero-internal cusp in the lower carnassial, as well as in the entire absence of the anterior accessory cusps in the upper and the first two lower premolars, the Sivalik

species comes closer to *H. crocuta*. *H. felina* differs from all other species of *Hyæna*, living or extinct, in the absence of the upper premolar 1. *Felis grandicristata*, which was of about the same size as some of the larger varieties of the Royal Tiger, had the sagittal crest even more prominent than the *F. cristata* of Falconer & Cautley. *Machærodus sivalensis* was of about the same size as the Jaguar. One of the specimens, on which this species is based, shows two molars in the deciduous dentition instead of three (as in the genus *Felis*). *M. palæindicus* was considerably larger than *M. sivalensis*. Both differ from all other known species of *Machærodus* in the form of the lower jaw &c.

### MISCELLANEOUS.

*On Archæopteryx macroura.* By Prof. CARL VOGT.

Prof. VOGT read before the last meeting of the "Société Helvétique des Sciences Naturelles," held at St. Gall in August 1879, a communication on *Archæopteryx macroura*. He remarked, first, that in 1861 Hermann von Meyer described a bird's feather found in the lithographic stone of Solenhofen in Bavaria, belonging to the Upper Jurassic deposits. The German palæontologist gave the name of *Archæopteryx lithographica* to the bird revealed by this feather.

In 1863 Prof. Owen described, under the name of *Archæopteryx macroura*, a much more important specimen from the same beds, and found by M. Häberlein, a doctor at Pappenheim. This was a slab showing with the greatest distinctness the hinder part of a bird, and also the feathers of the wings in disorder, as well as a few bones belonging to the anterior limbs.

M. Häberlein's son has discovered a new slab containing a second example of *Archæopteryx*, which Prof. Vogt has been able to examine. This new specimen is complete; and its wings are unfolded as if in flight.

The head is small; with the lens two small conical pointed teeth may be observed implanted in the upper jaw.

M. Vogt counted eight cylindrical cervical vertebræ, furnished with very fine, backwardly directed ribs. The dorsal vertebræ appear to be ten in number; they are thick and short, and bear no spinous apophyses. The ribs attached to them are very fine, slender, curved and pointed at the end; they show neither any flattening nor any traces of the uncinatæ apophyses which occur in birds. There are very fine sternal ribs, which appear to be attached to a linear abdominal sternum.

The pelvis is still involved in the matrix. The tail, which is very long, is preserved throughout its whole extent. However, it teaches nothing more than was known from Prof. Owen's specimen.

The posterior limbs, which are not, on the whole, so well preserved as in the first example, show nevertheless with perfect certainty

that the fibula is completely united with the tibia, and only distinguished by the presence of a not very strongly marked longitudinal furrow.

On the other hand the anterior limb furnishes new and very interesting information.

The structure of the thoracic girdle is very difficult to understand.

M. Vogt thinks that two scapulæ are recognizable, and that there is no bone representing the furcula. According to him the two coracoids are in contact in the median line, and the sternum is reduced to zero.

The humerus, the ulna, and the radius, already well described by Owen, present no features peculiar to reptiles or to birds. The manus, which was very imperfect in the specimen described by Owen, is, on the contrary, very remarkably preserved in the new slab. The carpus shows only a single small globular bone. The digits, which are very well preserved in both limbs, enable us to rectify certain errors of Owen's, which, however, are very excusable, as the learned English palæontologist only knew a few scattered bones from this region.

The manus of *Archæopteryx* can be compared neither to that of a bird, nor to that of a Pterosaurian, but only to that of a tridactyle Lizard.

In each manus there are three long slender digits, armed with curved and sharp-edged claws. The thumb is the shortest; it is composed of a short metacarpal, a rather long phalange, and the ungual phalange. The other two digits have, besides the metacarpal, three normal phalanges.

The remiges were attached to the cubital margin of the forearm and manus, although no special adaptation of the skeleton to this end can be observed. The thumb was free like the other two digits, and did not bear a winglet. If the feathers had not been preserved, no one could ever have suspected, from the examination of the skeleton alone of *Archæopteryx*, that this animal was furnished with wings when alive; for its manus, unlike that of birds, presents no trace of adaptation to the support of the remiges.

The following is a summary of what we know of the organization of *Archæopteryx*:—

The head, the neck, the thorax with the ribs, the tail, the thoracic girdle and the whole anterior member are clearly constructed as in reptiles; the pelvis has probably more relation to that of reptiles than to that of birds; the posterior limb, on the contrary, is that of a bird. In all respects the reptilian homologies predominate in the skeleton.

There remain the feathers. Here there is no doubt; they are bird's feathers with a central rachis and with perfectly formed barbules. The horny substance of the feathers has disappeared; but the model in the fine paste of the lithographic stone is so complete that we may study the smallest details with the lens. The new slab shows all the feathers in their place.

The remiges are attached to the cubital margin of the arm and



hand; they are covered for about half their length with a fine filiform down; none of the remiges projects beyond the others; the wing is rounded in its outline like that of a fowl.

It is possible that there was at the base of the neck a collar similar to that of the condor; at least it has been thought that indications of such a thing could be seen.

The tibia was covered with feathers throughout its whole length. The *Archæopteryx* therefore had breeches, like our falcons, with which, according to Prof. Owen, it has the most resemblance in the leg.

Each caudal vertebra bore a pair of lateral rectrices, all the rest of the body, head, neck, and trunk were evidently destitute of feathers and naked; we should certainly otherwise have found traces of feathers upon a slab which has preserved even the smallest details of a fine down. Hence the restorations of the animal hitherto attempted are quite erroneous.

According to M. Vogt it is quite unnecessary to discuss the question whether *Archæopteryx* is to be classed among reptiles or among birds. It is neither one nor the other; it constitutes an intermediate type of the most strongly marked description, and confirms in a brilliant manner the opinions of Prof. Huxley, who has united the reptiles and birds, under the name of Sauropsida, to form a single great section of Vertebrata. *Archæopteryx* is undoubtedly one of the most important sign-posts on the road which has been followed by the class of birds in differentiating itself more and more from the reptiles from which it originated. A bird by its integument and hinder limbs, the *Archæopteryx* is a reptile by all the rest of its organization; its conformation can only be understood by accepting this evolution of the birds by a progressive development from certain types of reptiles. The Cretaceous birds, so well described by Prof. Marsh, constitute a later finger-post on this road, as they still retain teeth while almost the whole of their organism is already conformable to the type of birds.

M. Vogt then discusses the stages by which *Archæopteryx* passed to arrive at the form under which we know it, and the mode in which adaptation to flight has acted upon the different parts of the body. He shows, in the first place, that this adaptation is by no means necessarily combined in the Vertebrata with that of a vertical position. We have the proof of this in Pterosauria and the Bats. The conformation of the hind feet, such as we see in the Dinosauria, the *Archæopteryx*, and birds, is therefore independent of the faculty of flight, and is only in relation to the possibility of sustaining the body upon the posterior feet alone. The relation found from this point of view between the Dinosauria and birds by no means indicates real affinities. At the utmost we might suppose a genetic connexion between the Dinosauria and the Ratitæ. But if we adopted this filiation, it would be necessary to assume a polyphyletic origin for birds.

Finally, M. Vogt inquires whether there are to be found, in deposits older than the Upper Jura, reptiles which may be related to *Archæ-*

*pteryx*. At present it is impossible to answer this question, because the fossils that we possess are destitute of their integuments, and it is very difficult to say *à priori* with what cutaneous structures these creatures were covered. There is complete homology between the scales or the spines of reptiles on the one hand, and the feathers of birds on the other. The reptilian structures differ in no respect from the wart-like stumps which appear in the embryo bird as the first traces of plumage; the feather of the bird is only a reptile's scale further developed; and the reptile's scale is only a feather which has remained in the embryonic condition. There can consequently be no doubt that the feathers of *Archæopteryx*, which are so perfectly developed, must have been preceded in other preexisting reptiles by cutaneous structures representing in a persistent fashion the different stages of the embryonic development of the feather. We must therefore imagine the ancestors of the *Archæopteryx* as lizard-like terrestrial reptiles, having feet with five, hooked, free digits, showing no modification in their skeleton, but having the skin furnished at different points with elongated warts, downy plumes, and rudimentary feathers, not yet fitted for flight, but susceptible of further development in the course of generations.—*Bibliothèque Universelle, Archives des Sciences*, December 15, 1879, pp. 702-708.

*Note on the Genus Brahmæa of Walker.*

By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

The first figure of a species in this genus is that by Petiver (Gazoph. tab. 18. fig. 3), a perfectly recognizable illustration of a species recorded as coming from the island of Chusan, and, as I have noted (P. Z. S. 1866, p. 458), identical with *B. lunulata* and *undulata* of Bremer, a good figure of which is given in Ménétrié's Catalogue of the Lepidoptera in the St.-Petersburg Museum (pt. iii. pl. 15. fig. 5).

The first description of an Oriental species is that of *B. certhia* given by Fabricius in the 'Entomologia Systematica,' iii. 1, p. 412. n. 16 (1797); and as this description does not seem to have been looked at by living Lepidopterists, at any rate in recent years, it will perhaps astonish them not a little if I quote it verbatim:—

"*Certhia*. 16. *B. alis patulis rotundatis fuscis apice cinereo albo fuscoque undatis*.

"Petiv. Gazoph. tab. 18. fig. 3.

"Habitat in Chusan. Mus. Brit.

"Magna. Corpus fuscum collari abdominisque lateribus cinereis. Alæ omnes concolores, basi fuscae, apice cinereæ, albo fuscoque undatæ."

Therefore there cannot be a question that the *B. lunulata* (and *undulata*) of Bremer is the typical *B. certhia* of Fabricius. The *B. certhia* of Walker, figured by myself (P. Z. S. 1866, p. 119, fig. 1), may consequently be named *B. conchifera*, on account of the beautifully shaded shell-like submarginal spots upon the wings.

Another point in the synonymy of this genus has also been cleared up through the transfer of the types of Lepidoptera in the India Museum. Among these we received a Nepal species bearing the type-labels of *B. Wallichii*, Gray, and *B. spectabilis*, Hope, and agreeing perfectly with both descriptions and the figure. The specimen is from the collection of General Hardwicke, as stated by Hope, and differs strikingly, both in coloration and pattern, on both surfaces from the better-known *B. conchifera* of Darjeeling and Silhet.

The true *B. certhia* of Fabricius, which 83 years ago was quoted as in the British Museum, is now also not to be found.

Two examples of *B. Wallichii* in Mr. Dana's collection agree in all important characters with the type.

### *New Classification of the Crustacea.*

By A. S. PACKARD, JUN.

The recent studies on the embryology of the king crab (*Limulus polyphemus*) have shown that there are some unexpected resemblances to the mode of development of the Arachnida; and while in our essay\* on the development of this crustacean we attempted to show that the arachnidan features were also to be found in certain crabs and shrimps whose development was exceptional, one or two naturalists (as E. Van Beneden and Dohrn) claim that *Limulus* is not a true crustacean, but belongs next to or with the Arachnida. This seems to us an extreme view. Then followed the beautiful anatomical researches of Alphonse Milne-Edwards on *Limulus polyphemus*, in which he showed the singular relation between the vascular and nervous systems, the latter being enveloped by the ventral system of the arteries. The differences between the nervous system of the king crab and Arachnida has been already indicated†. It has not been, we think, sufficiently taken into account that *Limulus* is a generalized or synthetic type, combining with features of its own certain resemblances to the Arachnida and to the normal Crustacea. In its mode of respiration, its external gills, and in its circulatory organs it is, as we have previously stated‡, essentially a crustacean, but should be placed apart from the normal Crustacea, and form the living representative of a subclass, equivalent to all the other living Crustacea. To *Limulus* are closely allied the fossil Merostomata; and we regard, for reasons already stated, the Trilobites as closely allied to the Merostomata.

For this subclass we have proposed the name Palæocarida; and for the normal Crustacea we have proposed the term Neocarida.

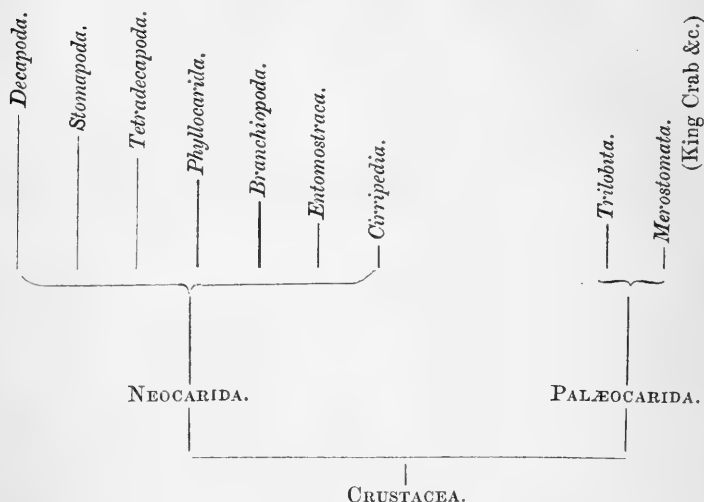
\* "The Development of *Limulus polyphemus*," by A. S. Packard, Jun. (Memoirs of the Boston Soc. of Nat. Hist., published March 1872).

† 'American Naturalist,' vol. ix. pp. 422, 423, July 1875.

‡ "Further Observations on the Embryology of *Limulus*, with notes on its Affinities," American Naturalist, Nov. 1873, vol. vii. p. 675.

In order to express the relations of the two subclasses of Crustacea, we have published \* the following table, showing the mode of grouping of the different orders of the two subclasses of the class of Crustacea:—

*Classification of the Subclasses and Orders of Crustacea.*



While the Neocarida are characterized by the well-known features peculiar to all living Crustacea except *Limulus*, the Palæocarida have, among others, the following characters:—Appendages of the cephalothorax in the form of legs rather than jaws; no antennæ; brain on the same plane as the cephalothoracic ganglionic ring, and supplying nerves to the eyes alone; nerves to the cephalothoracic appendages sent off from an œsophageal ring; nervous system ensheathed by a ventral system of arteries; metamorphosis slight. Sexes distinct.

Order 1. Merostomata.—No distinct thoracic segments and appendages. (*Limulus*, *Eurypterus*, &c.)

Order 2. Trilobita.—Numerous free thoracic segments and jointed appendages. (*Agnostus*, *Paradoxides*, *Calymene*, *Trinucleus*, *Asaphus*, &c.; all extinct.)

A further elaboration of this classification, with full references to the labours of others, is to be given in a second memoir on the anatomy and development of *Limulus polyphemus*, in course of preparation.—*American Naturalist*, December 1879.

\* Zoology for Students and General Readers. American Science Series. By A. S. Packard, Jun. H. Holt & Co., New York. Published in December 1879. 8vo, pp. 703.

*On two new Species of Cephalopods.*

By A. E. VERRILL.

Among the numerous additions recently made to the marine fauna of our coast by the fishermen of Gloucester, Mass., are two new species of Cephalopods. They both belong to the eight-armed division. One is a true *Octopus*. The other and more interesting one is the second known representative of the remarkable family of Cirroteuthidæ, characterized by the presence of a pair of fins, one on each side of the body, supported by a transverse cartilage—by the presence of a great web, surrounding and uniting all the arms nearly to their tips—and by the presence of two slender cirri between the suckers along the greater part of the length of the arms.

Our species differs so widely from *Cirroteuthis Mülleri*, Esch., the only representative of the family hitherto described, that it is necessary to constitute for it a new genus.

## STAUROTEUTHIS, gen. nov.

Allied to *Cirroteuthis*, but with the mantle united to the head all around, and to the dorsal side of the slender siphon, which it surrounds like a close collar, leaving only a very narrow opening around the base of the siphon, laterally and ventrally. Fins triangular, in advance of the middle of the body. Dorsal cartilage forming a median angle directed backward. Body flattened, soft, bordered by a membrane. Eyes covered by the integument. Web not reaching the tips of the arms, the edge concave in the intervals. Suckers in one row. Cirri absent between the basal and terminal suckers. Right arm of second pair altered, in the male, at the tip.

*Stauroteuthis syrtensis*, sp. nov.

♂. Head broad, depressed, not very distinct from the body. Eyes large. Body elongated, flattened, soft or gelatinous, widest in the middle, narrowed but little forward, but decidedly tapered, back of the fins, to the flat, obtuse, or subtruncate tail. The sides of the head and of the body, forward of the fins, are bordered by a thin soft membrane, about half an inch wide. The fins are elongated, triangular, obtusely pointed, placed in advance of the middle of the body. Siphon elongated, slender, round, with a small terminal opening. Mantle-edge so contracted and thickened around its base as to show scarcely any opening, and united to it dorsally. Arms long, slender, subequal, each united to the great web by a broad membrane developed on its outer side, widest (about 1.5 inch) in the middle of the arm, while the edge of the web unites directly to the sides of the arms and runs along the free portion toward the very slender tip, as a border. This arrangement gives a swollen or campanulate form to the extended web. Edges of the web incurved between the arms, widest between the two lateral pairs of arms. The arms bear each fifty-five or more suckers, in a single row. Those in the middle region are wide apart (.5 inch or

more) with a pair of slender thread-like cirri, about 1 inch long, midway between them. The cirri commence, in a rudimentary form, between the 5th and 6th suckers on the dorsal arms, and between the 7th and 8th on the ventral ones. They cease before the 23rd sucker on the dorsal and lateral arms, and before the 22nd on the ventral ones. Near the mouth and beyond the last cirri on the free portion of the arms the suckers are more closely arranged. They are small, with a deep cavity. Colour (in alcohol) generally pale, with irregular mottlings and streaks of dull brownish; inner surface of arms and web toward the base, and membrane around the mouth, deep purplish brown. Length from end of body to base of arms 6·30 inches, length to posterior base of fins 2·50, to anterior base 4; width across fins 5, in advance of fins 2·70 (not including lateral membrane), across eyes 1·75, across end of tail 1·20; diameter of eye 1; width of fins at base 1·20, their length 1·75; length of arms 13 to 14, portion beyond web 2·5 to 3; edge of extended web, between upper arms, about 4, between lateral arms about 8; entire circumference of web about 48.

Taken by Capt. Melvin Gilpatrick and crew, schooner 'Polar Wave,' N. lat. 43° 54', W. long. 58° 44', on Banquereau, about 30 miles east of Sable Island, in 250 fathoms. Presented to the U.S. Fish Commission, Sept. 1879.

*Octopus piscatorum*, sp. nov.

Body of female smooth, depressed, about as broad as long, obtusely rounded posteriorly, not showing any lateral ridges, nor dorsal papillæ. No cirrus above the eyes. Arms long, rather slender, tapering to long, slender, acute tips, the upper ones a little ( $\frac{1}{4}$  of an inch) shorter than those of the second pair, which are the longest; the third pair are about  $\frac{1}{2}$  inch shorter than the second; the ventral pair about  $\frac{1}{4}$  inch shorter than the third. In our specimen all the arms on the right side are somewhat shorter than those on the left, and the web between the 1st and 2nd arms is narrower, due perhaps to recovery from an injury. The suckers are moderately large, alternating in two regular rows, except close to the mouth, where a few stand nearly in a single line; about fourteen to sixteen are situated on the part of the arms included within the interbrachial web. The whole number of suckers on one arm is upwards of seventy. The web between the arms, except ventrally, is of about equal width, and scarcely more than one fourth the length of the arms, measuring from the beak. Between the ventral arms the web is about half as wide as between the lateral.

Colour of alcoholic specimen deep purplish brown, due to very numerous, crowded, minute specks; eyelids whitish. The front border of mantle beneath, with base of siphon and adjacent parts, is white; end of siphon brown. Lower side of head and arms lighter than the dorsal side. Total length from posterior end of body to tip of arms, of 1st pair 6·20 inches, 2nd pair 6·30, 3rd pair 5·75, 4th pair 5·25, to web between dorsal arms 3·25, between

ventral arms 2·50, to edge of mantle beneath 1·20, to centre of eye 1·55; breadth of body 1·25, of head across eyes 1·20, of arms at base ·22; diameter of largest suckers ·10; length of arms beyond web (1st pair) 3·00, 2nd pair 3·25, 3rd pair 2·80, 4th pair 2·75.

Taken by Capt. John McInnis and crew of the schooner 'M. H. Perkins,' from the western part of Le Have Bank, off Nova Scotia, in 120 fathoms. Presented to the U.S. Fish Commission, Oct. 1879. •

This species is easily distinguished from *O. Bairdii*, by its more elongated body, its much longer and more tapered arms, with shorter web, by the absence of the large, rough, pointed papilla or cirrus above the eyes, and by its general smoothness. The white colour of the underside of the neck, siphon, and mantle-border also appears to be characteristic.—*Amer. Journ. Sci. and Arts*, December 1879.

#### On *Amœba Blattæ*.

Prof. Leidy remarked that while perusing the communication of Prof. Bütschli on *Flagellata* and other related organisms ("Beiträge zur Kenntniss der Flagellaten und einiger verwandten Organismen") in the *Zeitschrift für wissenschaftliche Zoologie*, 1878, p. 205, his attention was especially attracted by the description of a parasitic amœboid living in the intestine of the cockroach (*Blatta orientalis*). It recalled to mind that he had observed the same creature a number of years ago, in association with the ciliated infusorian he had described as *Nyctotherus ovalis*. At that time he had viewed it as a young form of a Gregarina, and had intended giving it and other parasites of the cockroach more critical examination, but failed to do so. The parasitic amœboid which Prof. Bütschli describes under the name of *Amœba Blattæ* is particularly interesting on account of its habits and its somewhat peculiar character. Prof. Leidy had recently examined some cockroaches, and found abundance of the amœboid in association with *Nyctotherus ovalis*, *Lophomonas blattarum*, *Oxygurus gracilis*, and *O. appendiculatus*, and an algal plant.

The amœboid, he thought, was worthy of generic distinction from the true *Amœba*, holding a position between this and *Protophylla*. From the former it differed in the absence of a contractile vesicle and commonly also of vacuoles, and in the want of differentiation of endosarc and ectosarc; and from the latter in the possession of a well-defined nucleus. He proposed for it the following name with distinctive characters:—

#### ENDAMCEBA.

General character and habit of *Amœba*; composed of colourless, homogeneous, granular protoplasm, in the ordinary normal active condition without distinction of ectosarc and endosarc; with a distinct nucleolated nucleus, but ordinarily with neither contractile vesicle nor vacuoles.

*Endamæba blattæ.*

*Eine Art Proteus*, Seibold, Beitr. z. Naturges. d. wirb. Thiere, 1839, *vide* Stein.

*Amöbenform*, Stein, Organismus d. Infusionsthier, 1867, ii. p. 345.

*Amæba Blattæ*, Bütschli, Zeitsch. f. wiss. Zoologie, 1878, xxx. p. 273, Taf. xv. fig. 26.

Initial form globular, passing into spheroidal, oval, or variously lobate forms, mostly clavate, and moving with the broader pole in advance. Protoplasm finely granular, and when in motion more or less distinctly striate. Nucleus spherical, granular, with a large nucleolus. Distinct food particles commonly few or none. Size of globular forms 0.054 millim. to 0.075 in diameter; elongated forms 0.075 by 0.06 to 0.15 by 0.09 millim. Parasitic in the large intestine of *Blatta orientalis*.

The *Endamæba blattæ* affords a good example of a primitive active nucleated organic corpuscle, or a so-called organic cell without a cell-wall. In the encysted condition it would be a complete nucleated organic cell. *Endamæba* may be recommended as a convenient illustration of a primitive form of the organic cell, on account of its comparatively ready accessibility.—*Proc. Acad. Nat. Sci. Philad.*, October 7, 1879.

*On the Habits and Parthenogenesis of the Halicti.*

By M. J. H. FABRES.

Two species have chiefly furnished the materials for the preparation of this paper, namely *Halictus lineolatus*, Lep., and *H. saxicinctus*, Latr. The investigation of the former was made under the most favourable conditions; every day, at whatever moment he chose, and from one end of the year to the other, the observer had under his eyes the object of his inquiries in its natural state of being. The place of observation was in front of his door, in the open country, in the midst of meadows. It was among the osier-beds of the alluvial deposits of the Aygues, a torrent to the north of Orange, that the second species (*H. saxicinctus*) was observed, in a colony sufficiently populous to lend itself to detailed observations. Followed up for a whole year, the study of these Hymenoptera has furnished the following results.

Among the *Halicti* there is no society in the entomological sense of the word: the family is not common; and the cares of all have not in view the interests of all. Each mother is only preoccupied with her own oviposition, and constructs cells and collects pollen only for her own larvæ, without interfering at all with the rearing of the larvæ of others; but there is nevertheless cooperation between them for general work, of which several may take advantage without hampering each other. This common work is the gallery, which, ramifying in the depths of the soil, gives access to various groups of cells, each of which groups is the property of a single *Halictus*.



A single entrance-gate and a single passage thus correspond to several distinct domiciles.

It is especially at night that these digging labours for the excavation of the cells and the boring of new galleries are performed. A cone of fresh earth raised on the threshold of the orifice of the passage bears witness every morning to the nocturnal activity, and by its size proves that several Hymenoptera have participated in the work.

The cells of the *Halicti* consist of oval excavations, narrowed into a neck at the upper part. Their walls are varnished with a waterproof coating, which adds to the delicate polish of the chamber and protects the interior from the invasion of damp. This varnish is of the same nature as the goldbeater's-skin-like substance with which the *Colletæ* line their galleries and construct their little honey-bags. Every thing tends to prove that this product of the two types of Hymenoptera is of salivary origin, and may be compared to the mucosity which certain birds, such as the swift and the salangane, introduce into the construction of their nests.

For the *Halicti* September is solely the month of amours. Then the males, whose number exceeds that of the females, dance incessantly over the burrows and make their way into the passages. The females remain in retirement in their cells or in the galleries, and the copulation takes place underground. When the first chills of November arrive all the males have disappeared; and the females, which are then fertilized, pass the winter enclosed in their cells.

Towards the month of May the females, fertilized in the autumn, issue from their burrows and work at the nest in the absence of all males, whose assistance, however, is none the less real because it has preceded the oviposition by six months.

In July a second generation is produced, without the presence of any males; but this time the want of cooperation of one of the sexes is no longer an appearance, but a reality placed beyond doubt by the continuity of the observations.

Two months later males and females are produced from this generation of a single sex. Fecundation takes place underground; the males perish; the females hibernate; and the same order of things recommences.

Thus the *Halicti* have two generations yearly:—one in the spring, sexual, proceeding from mothers which, having been fertilized in the autumn, have passed the winter in their cells; the other, æstival, due to parthenogenesis. From the concourse of the two sexes females alone are produced; from parthenogenesis originate both males and females.

From this it seems probable that other insects with several ovipositions in the year may possess the double mode of reproduction of the *Halicti*; but, with the exception of the Aphides, the parthenogenesis of which has so long been known, what are these insects? and if there are such, do they confirm the suspicions to which the *Halicti* give rise? This the author proposes to investigate.

*Halictus sexcinctus* has *Myodites subdipterus* as a parasite. The larva of this curious fly-like beetle devours the larva of the Hymenopteron when the latter has finished its provision of honey. The author does not yet know how the parasitic worm-like creature, which is incapable of progression, is introduced into the cell of the *Halictus*. Perhaps there may be here an initial transfiguration, and habits having some analogy to those of the Meloïdes.—*Comptes Rendus*, Dec. 22, 1879, p. 1079.

*On the Locomotion of Insects and Arachnida.*

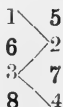
By M. G. CARLET.

The mode of locomotion of insects and Arachnida is much more regular than is usually supposed. The only rule laid down by authors is that the two legs of the same pair never move simultaneously. By examining insects the movements of which are slow and the legs equidistant, such as *Oryctes nasicornis* and *Timarcha tenebricosa*, we see that the limbs move as indicated in the following table, in which the legs are arranged in their natural position, and the numbers indicate the order in which they are raised:—



Whilst the legs 1, 2, 3 are raised almost simultaneously, the legs 4, 5, 6 remain in support, to be raised in their turn when the former have come to rest. In other words, the insect rests upon a triangle of sustentation formed by the two extreme feet of the same side and the middle foot of the other side, while it moves forward the other three feet. I have ascertained that this mode of locomotion is equally characteristic of the other orders of insects.

*Arachnida*.—I have been able to follow very clearly the order of movement of the legs in the female of *Epeira diadema*. It is almost impossible to catch this order in male spiders, in consequence of the rapidity of their progression. In the females the voluminous abdomen forms a burden which retards movement and enables the following table to be traced:—



Here the polygon of sustentation is a quadrangle formed on the one side by the feet of even numbers, and on the other by those of odd numbers.—*Comptes Rendus*, December 29, 1879, p. 1124.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

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### XVI.—*Investigations on the Development of the Spiders.*

By Dr. J. BARROIS \*.

[Plate IX.]

MY researches upon the development of the Spiders have been directed to various species—*Tegenaria domestica*, several undetermined species of *Lycosa*, and especially *Epeïra diadema*, already studied by Herold. The object that I particularly proposed to myself was to trace by means of sections the arrangement of the lamellæ and the phenomena of internal development, which have never been investigated in this group of animals. My studies have led me to modify some of the opinions hitherto accepted upon the external development; and I shall give these results together with the others. My process of research has been the observation either of fresh or slightly heated ova, or of ova coloured by bichromate of potash and osmic acid, hardened by alcohol, and cleared by essential oil of cloves; by means of the last we succeed much better in seeing the different parts. In making the sections, I employed especially Leyser's microtome, now used almost everywhere in Germany, and which I owe to the kindness of Professor Leuckart, to whom I am glad to have the opportunity of offering my thanks.

\* Translated by W. S. Dallas, F.L.S., from a separate copy, furnished by the author, of the memoir published in the 'Journal de l'Anatomie et de la Physiologie,' tome xiv. pp. 529-547.

Before approaching the special subject of my memoir I will say a few words as to the formation of the blastoderm.

Since Balbiani's memoir, Ludwig has published a very complete treatise upon this subject: I adopt most of the results of this author; but there are some observations which I must offer. Ludwig has asserted that the granular layer placed by Balbiani at the surface of the vitellus (*couche plastique* of Balbiani) really belonged to the vitelline membrane; I must declare myself against this assertion. I have, in fact, found over the vitelline membrane a special layer not described by Balbiani, to which, as Ludwig says, is due the network that we observe at the surface of the ovum: it is not formed by a continuous layer of juxtaposed globules, but only of globules arranged in lines which intercross to form a kind of net, in the meshes of which the vitelline membrane is uncovered; the whole appears most distinctly in the ova of *Epeïra diadema* treated with nitrate of silver. Independently of this reticulated layer, I further distinguish, like Balbiani, the formative globules of the cells of the blastoderm. These sometimes acquire large dimensions, and present great regularity; one cannot mistake their identity with the elements described by Balbiani when one observes the ova of *Tege-naria domestica*.

I therefore regard the description given by Balbiani of the granules of the plastic layer as perfectly correct, and am of opinion that this observer has done good service by drawing attention to the strongly granular character of the protoplasm in the Spiders; but I adhere rather to Ludwig as regards the distribution of these protoplasmic elements. I have never seen them form a continuous layer at the surface of the ovum, nor divide up into germinative areas; but I see them constantly appear in the form of trains or series between the vitelline globules of the surface. Ludwig's deutoplasm-columns (*Deutoplasmasäulen*) are generally to be recognized without difficulty; but I have not been able to see them in all the species—which, without invalidating the description given by Ludwig, leads me to doubt the absolute necessity of a regular arrangement of the masses of deutoplasm. There may be a greater condensation of the embryogeny in certain species, so as to arrive at such a distribution of the protoplasm, but without such a complete fusion of the masses of deutoplasm into deutoplasm-columns—which would carry back the essential characters of the formation of the blastoderm to the strongly granulated character of the protoplasm, and to its first appearance between the vitelline globules of the surface.

This being stated, we may pass to the formation of the embryo.

The first observer who occupied himself seriously with this subject did not go so far as to the formation of the ventral embryonic band; he only described the thickening of the blastoderm, and then passed without any transition to the stage of the young spider rolled up in the egg, leaving an enormous hiatus.

This gap was in part filled up by Claparède, who greatly added to our knowledge on this subject by describing the development of the embryonic band, its subsequent division into ventral pads, and its segmentation into zonites of three kinds—thoracic, abdominal, and postabdominal. Nevertheless even he saw only half the phenomena; his description omits, between the last stage of the embryonic bands and the young spider, a second series of important phenomena which have hitherto remained unknown.

In what follows I shall divide the subject into three parts:—

1. The stage of the embryonic bands, described by Claparède, as to which I have only a few supplementary notes to add;
2. The Limuloid stage, hitherto unknown, and which I shall have to describe completely;
3. The stage of the young spider rolled up in the egg, already well investigated by Herold, but which we shall have to reconsider from the point of view of the lamellæ.

### I. *Embryonic Band.*

If we make a section of the egg at this stage, we see that Claparède's ventral pads are really composed of two lamellæ:—1, the external simple one, which extends over the whole surface of the egg; and 2, the intermediate one, arranged in two cords, formed of several rows of embryonic cells: these cords exactly correspond to the ventral pads; and I reserve to them the name of *germinative bands*. These germinative bands exist throughout the whole length of the egg. They are derived from the scission of an originally continuous mesodermic band, but do not present the same arrangement throughout: in the abdominal region they are thin and of but small extent; in the future thoracic region, on the contrary, they are much larger, and begin to show a division into a central part (the nervous bands) still adherent to the external lamella, and a peripheral part, which is purely mesodermic. In front the two germinative bands pass to two projections of a circular form, direct prolongations of their nervous portion, which will form the cerebral lobes; these are the representatives of the procephalic lobes of Claparède and Huxley

(*Scheitelflatten* of German authors). These lobes are bounded within and above by a groove bordered on all sides by a projecting crest due to a thickening of the cells of the blastoderm. This crest forms between the lobes a projecting tongue, no doubt the representative of the labrum (*Vorderkopf* of the Germans), and is afterwards produced on each side into two semi-circular thickenings which surround the cephalic lobes on the outside. The base of the tongue, which represents the labrum, presents a deepening of its median furrow, which indicates the commencement of the invagination of the œsophagus and constitutes the mouth. We see that the structure of the cephalic region is much more complex than Claparède supposed, and that we can recognize in it all the constituent parts of the head of the Arthropoda; its aspect presents striking analogies with what Metschnikoff has described in the Scorpions: the labium does not appear to be formed until a little later, and independently of the cephalic portion, at the expense of a median thickening of the mesoderm, placed between the first union of the two nervous bands below the œsophagus (see Pl. IX. figs. 2, 3, 7).

As regards the number of zonites of the embryonic band, I have found it, at least in *Epeïra diadema*, greater than that given by Claparède. The number of segments following the six thoracic ones appears to me in general to amount to ten (including the anal hood); the first four are more developed and constantly bear rudiments of limbs; all the others have always seemed to me destitute of appendages.

Besides the rudiment of a limb, or the vacant space which takes its place and forms the median part directly superimposed upon the germinative band of each of the segments, all the zonites of the abdomen always present, towards the last periods of the stage of the embryonic band, two lateral portions, a sternal and a tergal plate, formed by thickened cells of the blastoderm, beneath which the mesoderm of the germinative bands has begun to spread out in a thin layer. The tergals are always perfectly visible, and are wider in the four anterior abdominal segments; the sternals in the posterior segments appear under the form of perfectly distinct, thin, elongated plates, which may easily be mistaken for rudiments of limbs (as no doubt has been done by Claparède) if one does not pay particular attention to their position. In reality the six posterior segments have always seemed to me to be destitute of appendages; their median portion, superimposed upon the germinative band, being only occupied by a paler line.

This appearance of the sternal and tergal arcs shows us that

at this stage the ventral pads do not tend to become effaced, as Claparède says, but that, on the contrary, they are in a progressive course; we see, moreover, that the formation of appendages is not irregular and variable according to the species, but that it is constantly limited to the first four zonites.

## II. *Limuloid Stage.*

According to Claparède, the whole passage from the state of embryonic band to that of the young spider rolled up in the egg is reduced to a translation of the ventral pads towards the dorsal region; this displacement in its turn causes an approximation towards the ventral region of the two extremities of the embryo, and thus produces its rolling up in proportion as the ventral pads separate from each other. The nutritive vitellus protrudes through the fissure which these pads have left between them (*fente sternale*, Clap.), and finally passes entirely through this fissure, so as to become completely ventral: the position of the embryo is thus entirely changed; and it becomes rolled in the opposite direction to its former one.

This process is completed at the period when the ventral pads have come to occupy the lateral epimeral region, of which, according to Claparède, they are the representatives (we have seen that this interpretation is erroneous, and that they represent in addition the sternal and tergal arcs, the part occupied by the limb alone really forming the lateral region). Their presence at this point keeps the two faces of the embryo distinct for a moment; but they soon finally disappear, so that we no longer distinguish one face from the other, and the posterior part of the body assumes the globular form so characteristic of the abdomen in the adult.

The passage of the vitellus through the sternal fissure is a unique fact in the group Arthropoda; and the interpretation of it given by Claparède makes something quite peculiar out of the embryogeny of the Spiders. Ingenious as this conception may be, however, it is far from sufficing to explain the passage from the embryonic band to the state of the young spider rolled up in the egg, and one feels the necessity of a less theoretical description.

In order to trace this passage in all its details, we shall take up again the last stage of the germinative band and examine its changes step by step; the phenomena differ according as we examine the anterior, middle, or posterior portion of the body.

1. *Anterior portion.*—The buccal depression becomes invaginated, and gives origin to a tube; the latter, which grows

rapidly inwards, is destined to form the œsophagus, the sucking-stomach, and the portion of the intestine which immediately follows—in one word, all the median tubular portion of the digestive canal contained in the thorax: it is quite completed at the commencement of the third period, in the young spider rolled up in the egg.

As this invagination penetrates inwards it gives rise to concomitant modifications, which are of great importance in understanding the structure of the thorax. If we make a transverse section in the middle of the thorax of a spider, we see that the musculature is constituted as follows (see fig. 6):—1, a central part formed by three muscular bundles (*m*) attached to the œsophagus; the first, which is unpaired, is vertical, and is attached to the vertex of the body; the other two, paired, form a horizontal plane, and, covering the ventral ganglionic masses, pass to attach themselves to the bases of the legs; 2, of a peripheral part (*m'*) composed of fibres which skirt the wall, and which constantly go from the bases of the feet to the vertex of the body. This second part of the musculature is of comparatively late formation; it does not make its appearance until rather late, and only acquires its full growth during the postembryonic development: the first, on the contrary, appears early and proceeds *pari passu* with the invagination of the anterior part of the digestive tube. It would seem, in fact, that this invagination carries with it in its movement towards the posterior part (see figs. 4, 5) the peripheral portions of the germinative bands, in such a way as to form three cellular laminae—a median one detached from the cephalic portion, the other two lateral ones from the two germinative bands. These three laminae represent the three muscular planes marked *m* in fig. 6: the first, which directly surrounds the œsophagus (fig. 4, *m*), represents a longitudinal partition which will divide the cavity of the thorax into two parts; the two others, two transverse partitions which will soon unite into a single plane directly covering the ventral ganglia. Soon after the last stages of the embryonic band the cephalic portion is rounded behind, and, as Claparède has already stated, separated from the vitellus by a deep emargination; but after the period when the three cellular plates (*m*, fig. 4) begin to form, we see it produced into an elongated point, which is already figured by Claparède, and represents the vertical partition (*m*, fig. 6) which gradually elongates simultaneously with the œsophagus.

Figs. 4 and 5 show the three planes at the moment when they begin to detach themselves from the germinative bands. In proportion as the invagination of the œsophagus progresses



it carries them with it towards the posterior part: the vertical partition is thus carried to the end of the thorax, which it completely divides into two symmetrical halves (fig. 6, *cæ*), at first filled with nutritive vitellus; the transverse partitions are simply spread out and brought nearer to each other, so as to form a continuous muscular plane, situated at first in the fore part of the thorax. In thus approaching each other these two planes carry with them the two nervous bands, which they always immediately cover; and thus is effected the approximation of these latter to form a central mass, which directly afterwards divides into ganglia. This union of the nervous bands is therefore itself only a consequence of the growth of the invagination of the œsophagus; and all the phenomena which give origin to the thorax may be referred to this single cause.

When once these processes are completely terminated, the thorax is formed in all its more essential features. One of the chief effects of its formation is to restrict the cavity of the whole anterior part of the embryo; the vitellus is driven back towards the posterior part; and there only remains in the thorax the portion which will give origin to the cæca of the stomach.

2. *Median portion.*—In this portion we see each of the tergal and sternal pieces increase to unite with that of the opposite side, so as to form a complete arch. The tergal arcs grow rapidly; and we are soon able to distinguish perfectly distinct hemizonites formed by their union in the dorsal region. Of these we always distinguish four much wider than the others, formed by the first four abdominal segments; with the other narrower ones which follow them they constitute a dorsal plate, to which we shall refer again. The sternal arcs likewise increase, but more slowly; and, moreover, their union is prevented by the projection of the nutritive vitellus, which, pushed backward by the contraction of the thoracic region and by the formation of the complete tergal arches, protrudes through the sternal fissure, passing between the two hemisternals. At the same time that the thickening of the cells of the external lamella, which constitutes the sternal and tergal plates, advances more and more towards the median lines of the back and belly, the thin mesodermic layer subjacent to it likewise increases. At the period when the tergals have united to form complete arches, we also find a complete mesodermic layer, which extends beneath the whole of the tergal plate, and which from the first begins to thicken upon the median line, to give origin to the dorsal vessel; at the edges, between the sternals and the lateral region, there is always a

thickening, the still persistent remains of the germinative bands.

3. *Posterior extremity*.—At the period of the last stage of the embryonic band this latter runs completely round the egg, and its posterior extremity comes nearly into contact with the cephalic region; lastly the germinative bands, in running to unite in the anal hood (placed high up on the dorsal surface), form between them a very acute angle. In the subsequent stages we see the anal segment gradually increase its distance from the cephalic region, and pass more and more towards the ventral region; this displacement of the anal segment in its turn causes a modification in the separation of the germinative bands, the angle formed by their union tending to become more and more obtuse. The same processes continue regularly until the anal segment has come to occupy the extremity opposite to the cephalic region, at which period the two germinative bands have come into the same plane, the progressive separation of the two sides of the obtuse angle finally producing a straight line. If we imagine a continuation of the same phenomena, we shall see the anal segment come to occupy a position upon the ventral surface, and the germinative bands approach each other again, but in the inverse sense, so as to form an angle opposed to that which they formed at the commencement; this state concludes the process by which the posterior extremity of the embryonic bands, at first directed towards the dorsal side, becomes recurved towards the ventral region.

If we attempt to trace the same phenomena in Arthropods with a projecting caudal part (*e. g.* the Phryganidæ), in which the recurvation of the caudal part is regarded as the cause and origin of the whole inversion of the embryo in the egg, we shall find exactly the same phenomena (1, retraction of the caudal region and separation of the germinative bands; 2, arrival of the anal segment at the posterior pole of the egg, and arrival of the embryonic bands in the same plane; 3, arrival of the anal segment upon the ventral surface, and approximation of the embryonic bands in the inverse direction). The only difference consists in that the same phenomena will take place in the depth instead of at the surface of the egg: and this difference is not at all essential; for we may still recognize in the Spiders a remnant of a tendency of the caudal portion to detach itself from the rest of the vitellus; the anal segment almost always forms at first a strong projection, which indicates the commencement of this process. We shall therefore arrive at the conclusion that in the Spiders, as in the other Arthropoda, the cause and origin of the pheno-

menon of inversion resides essentially in the caudal region ; the protrusion of the nutritive vitellus through the sternal fissure is a *purely passive* feature of development, and determined by the pushing back of the vitellus towards the posterior region—a movement resulting from the three processes just indicated, all three of which produce, in different degrees, the effect of restricting the capacity of the embryo.

*Limuloid Stage.*—The three series of modifications that we have just indicated are not all produced with the same rapidity ; the last two are more rapid, and are seen completely finished at a period when the union of the two nervous bands has only commenced under the cephalic region. At this period, in consequence of these changes, the embryo presents a very remarkable aspect (see fig. 1). It is divided into two distinct parts, answering to the thoracic and abdominal segments, and which seem to me to correspond in a very striking manner to the two divisions of the body in the Xiphosura : the posterior portion, or tergal plate, is formed by the amalgamation of all the tergal arcs ; we can recognize in it each of the segments which formed the abdomen in the embryonic band ; but here this abdomen is divided into two parts—a preabdomen composed of six segments, and a narrow postabdomen formed of four segments. The preabdomen is itself subdivided into four broad zonites bearing appendages already indicated in the embryonic band, and two much narrower ones following the former. The anal segment at first appears simple ; and in *Epeira diadema* it is impossible to discover in it any trace of division. Nevertheless, by examining the sternal arcs we ascertain that the one corresponding to the anal segment is divided into three distinct pieces, which shows that this anal segment is here equivalent to three segments soldered together. This interpretation of the anal segment is not without interest, if we collate it with the fact, observed in *Pholcus* by Claparède, of the early division of the anal segment into three distinct segments. The fact observed in *Epeira diadema* shows that this is perhaps general, and that this division, although rarely so early, none the less virtually exists.

This multiple value of the anal segment brings the number of segments of the entire abdomen to twelve, and that of the postabdomen to six ; and this agrees within a segment with the exact number of zonites in the abdomen of the Scorpions, and corresponds exactly for the postabdomen. The stage fig. 1, so like the king-crabs in the division of the body into two portions, would thus prove to come very near the Scorpions in the number of zonites in the different divisions.

This fact teaches us to compare this stage with the fossil forms of the Merostomata, which so often resemble passage-types between the Scorpions and the Xiphosura. Among the latter there is even a form (*Hemiaspis limuloides*) which seems to me to recall in a striking manner the stage which I have indicated in the Spiders: in it the body is in like manner separated into two divisions, of which the posterior contains ten segments, which are divided in the same way into six preabdominal and four postabdominal, the last of which is elongated into a style; it may also be noted that the first four preabdominals in this species present traces of an organization somewhat superior to that of the two following ones. This predominance of the first four preabdominals moreover appears to me to be a very constant fact, not only among the Spiders, but in the whole group Arachnida.

Metschnikoff has already shown that in the Scorpions they appear at the same time and before all the others, and that the formation of the ventral ganglia in their interior also greatly precedes that of all the others. Unfortunately we do not possess, with regard to the *Limuli*, data sufficiently complete to enable us to judge whether this is the case in the Xiphosura. Fig. 1 shows that at this period these segments in the spider occupy a considerable space and form more than half the tergal plate.

Besides the embryo proper (fig. 1), we have still to consider in this stage the vitelline part (figs. 2, 3), bounded all round by the nervous bands and the sternal plates (fig. 3). This now represents only an *annex of the embryo*, and on all accounts merits the name of *vitelline vesicle*; in fact, as in the fishes, it forms a sac surrounded by a delicate blastoderm, projecting from the ventral surface; it is bounded on all sides by the embryonic parts, and, in like manner, owes its origin to a displacement towards the ventral part of a nutritive vitellus too abundant to be entirely contained within the embryo. Thus this hernia of the nutritive vitellus through the sternal fissure, regarded by Claparède as constituting a mode of reversal (*retournement*) of a special nature differentiating the development of the Spiders from that of the other Arthropods, is due, according to me, solely to the presence in the Spiders of a *vitelline vesicle* exactly like that of fishes: it is, I believe, the first instance to which attention has been called in the Invertebrata\*.

Leaving out of consideration this presence of the vitelline

\* Except perhaps in the *Salpæ*.

vesicle, the entire evolution agrees absolutely with the development of the other Arthropoda, and consists essentially in the following phenomena:—1, formation of a continuous mesodermic band, and appearance of the sternal fissure dividing this band into germinative bands; 2, appearance of the nervous portion within the latter; 3, growth of the germinative bands towards the tergal region, then towards the sternal; 4, recurvation of the tail, and reversal &c.

Fig. 5 represents the boundaries of the vitelline vesicle. It commences immediately below the point of union of the two nervous bands—that is to say, a little behind the mouth in the Limuloid stage; but it nevertheless already presents a sensible flattening over all the rest of the thoracic region, and only becomes greatly inflated beneath the abdominal region, where it presents a thick projection: fig. 6 will assist in rendering this arrangement intelligible.

*Passage to the young spider.*—If we imagine exclusion to take place at this period, the thorax will be completed by the completion of the invagination of the œsophagus and the concomitant phenomena: the abdomen will close up by the growth of the sternal bands; and the sternal vesicle, which they compress on all sides, will be absorbed by degrees, and enter gradually within the embryo in proportion as the sternal plates grow over it so as to complete the zonites of the abdomen. There will thus be formed an organism analogous to *Hemiaspis limuloides*, while the vitelline vesicle will follow the ordinary course of absorption.

In the Spiders this is not the case. The new phenomena which rapidly intervene confuse this normal course; the sternal vesicle does not disappear by absorption, but it is covered up by the exaggerated development of the tergal plate, and is entirely enclosed within the embryo. For this purpose we see all the tergal plate, but especially the four large anterior segments, increase both in length and breadth; the tergal plate, at first confined to the dorsal surface, thus gradually encroaches upon the vitelline vesicle, which it finally surrounds completely, leaving free only a small oval space indicated in fig. 2 by the line *bv*, which will be covered up by the development of the sternal plates. At the period when this envelopment is effected, the invagination of the œsophagus and the constriction of the nervous bands have been completed, and the thorax is finally constituted; further, at the boundary of each of the first four zonites of the abdomen there is formed a double fold of the mesoderm, composed of flat cells, which advances into the mass of the nutritive vitellus so as to constitute a true diaphragmatic

partition, like those which keep the digestive tube of the Annelids in place.

We have already seen that at this epoch these four zonites had arrived at their maximum development, and played the principal part in the envelopment of the vitelline vesicle by the tergal plate; at the period when this envelopment is completed, the segments of the postabdomen still occupy only a small space in the posterior part, and the abdomen is almost entirely formed by the first four preabdominals, the diaphragmatic partitions of which divide the vitellus into four large digitate masses, recognized and well figured by Herold and especially by Claparède, but of which they did not understand the signification. The abdomen of nearly all spiders is thus almost entirely composed of these four extraordinarily developed segments, which at last shows us their signification.

At the same time that these various phenomena take place, the space left free (fig. 2, *bv*) by the tergal plate is covered up by the sternal plates. It is at this period that the limbrudiments of the first four abdominal segments disappear, and that the boundary between the dorsal and ventral halves of the body seems to disappear, to give place to an abdomen of globular form, in which the limit between the sternals and the tergals is no longer precisely indicated. We see that at the period of this disappearance the ventral pads (in consequence of the growth of the tergal plate) occupy a very different position (*bv*, fig. 2) than was assigned to them by Claparède at the same epoch: the distinction between tergal and sternal arches persists to the last in the Spiders; but finally, as we have seen, there is no proportion between the two pieces, the tergal pieces having grown out of all proportion, and the sternals forming only an insignificant part. The complete disappearance of the lateral pads is caused by a displacement of the last vestiges of the germinative bands. We have seen that these last continued hitherto to form a slight thickening on the edges of the tergal plate; at the period when the sternals increase to cover up the portion left free by the tergal plate (fig. 2, *bv*), this thickening quits the lateral region and unites with that of the opposite side to form a compact mesodermic mass of oval form, upon the median line and immediately within the space covered up by the sternals. From this thickening will be formed later on the whole of the straight abdominal part of the digestive tube, the excretory organ, the spinning-glands, and the genital organs. The spinnerets themselves originate at this period, in the form of pretty large elevations of the skin, situated at the posterior limit of the sternal plates: at first they only appear in

two pairs; the third smaller pair is not formed until later. The spinnerets at first occupy a much larger space than they afterwards do; subsequently they become more concentrated and rise into small and more definitely circumscribed mamillæ.

### III. *The young Spider.*

The passage from the embryonic band to the young spider rolled up in the egg is therefore much more complex than as described by Claparède. It is during its progress that all the most essential phenomena of the internal development take place; and it consists, as we have seen, of two great periods—the passage from the embryonic band to the Limuloid stage, and the passage from the Limuloid stage to the young spider.

When this last stage is arrived at, the spider is constituted in all its most essential points, and already presents its definitive form. We can obtain a sufficiently good idea of the subsequent developmental aspects by consulting the figures given by Herold, who carefully studied this period. The most important phenomenon which occurs during it is the formation of the inner lamella, which is produced at the expense of the nutritive vitellus. Up to this time the vitelline masses retain an irregular arrangement. This irregularity persists in the masses of the centre, but ceases in those of the surface, which acquire a very regular arrangement at the period of the extension of the tergal plate. At the same time there appear between their boundaries trains of opaque granules; these trains rapidly increase in thickness, and soon present from place to place white spots recognizable as nuclei. These nuclei increase simultaneously with the granules. The latter represent the protoplasm, and speedily collect around the nuclei to form cells, which then begin rapidly to multiply and soon clothe the whole surface of the vitellus.

This appearance of the inner lamella is not without analogy with that of the blastoderm; and it would appear that, as Bobretzky has already indicated in *Palæmon* and *Oniscus*, the vitelline mass is twice active—once to form the outer lamella, and a second time to form the inner lamella. I do not think that we have here an immigration of blastodermic cells into the interior of the mass of the nutritive vitellus: I have never seen any thing that would justify such an assumption; and I rather incline to believe that the productive activity of the vitelline mass is not exhausted by the formation of the blastoderm, and that there remains in it sufficient to produce the nuclei which we see reappear in the trains of protoplasm.

The inner lamella thus produced is destined to form in the thorax the two pairs of cæca of the stomach, and in the abdomen the whole of the hepatic mass. The wall of the cæca of the stomach is formed at once by the simple fact of the appearance of a layer of cells at the surface of the two masses of nutritive vitellus (cæ, fig. 6); the vitellus which fills them is gradually absorbed. As regards the liver, the cells of the inner lamella begin by penetrating into the vitelline mass, at first skirting the diaphragmatic partitions and then the internal organs formed at the expense of the ventral mesodermic mass of the abdomen. In consequence of this penetration of the cells into the interior, the nutritive vitellus becomes divided into isolated fragments; and these are gradually absorbed in proportion as the surrounding endodermic cells multiply and take their place.

The liver and the two pairs of cæca of the stomach are therefore all developed at the expense of the inner lamella, while the straight tubular portion of the digestive canal, comprising the œsophagus, the sucking-stomach, the intestine, and the rectum, is developed at the expense of the two other lamellæ. The first two alone represent the endoderm; and it is evident that they only form a single part divided into two by the constriction of the thorax; in the Arachnida with an unpedunculated abdomen (*Chelifer*, Scorpions) they are not separated from each other.

Beyond this formation of the inner lamella I have nothing to describe, except some phenomena of detail which it would be tedious to enumerate here (differentiation of the ventral mesodermic mass of the abdomen, formation of the eyes, establishment of the circulation, &c.). The most important phenomena consist in the strong development of the peripheral musculature (*m'*, fig. 6), especially in front of the cerebral ganglia. At the commencement the internal organs, nervous masses, stomach, &c., are closely applied to the skin, from which they are separated only by a thin layer of mesodermic cells; the chelicerae are then still immediately anterior to the cerebral ganglia; and the anterior triangular plate of the thorax, which may still be distinguished even in the adult, evidently corresponds to the cerebral ganglia. Subsequently, when the thin mesodermic layer which clothes these organs has become developed into a powerful musculature, the internal organs are displaced inwards, and become greatly separated from the skin, which renders the relations of the divisions of the body to the internal organs more difficult of recognition. The chelicerae depart far from the ganglionic masses; and an entire long anterior portion seems to be added



to the cephalic portion: further, the muscular thickening at this point is such that the correspondence of the anterior thoracic plate and the cerebral ganglia is entirely masked. In the abdomen the peripheral musculature is represented by three groups of muscles (dorsal, ventral, and lateral)—the first formed at the expense of the mesoderm which surrounds the dorsal vessel, the other two at that of the ventral mesodermic mass.

A last fact which deserves to be mentioned is the considerable number of ganglionic masses of the thoracic region. The nervous bands, in dividing, form, not only the five pairs of large ganglia which persist in the adult, but also three or four smaller pairs applied to the lower surface of the peduncle and which are very visible shortly after exclusion; these are, no doubt, ganglia of abdominal segments which have concentrated themselves towards the thoracic region.

In conclusion, I may notice some interesting retrogressions which take place towards the close of the passage to the adult, such as the degeneration of the four diaphragmatic partitions, of the dorsal portion of the peripheral musculature of the abdomen, and of a considerable part of the nervous system.

#### EXPLANATION OF PLATE IX.

*Fig. 1.* Limuloid stage, seen from the back.

*Fig. 2.* The same, seen in profile. *l*, labium; *lc*, cephalic lobe; *b*, mouth; *vo*, sternal vesicle; *bv*, limit of the extension of the tergal plate.

*Fig. 3.* The same, seen on the ventral surface, and showing the distribution of the mesoderm, as well as the limits of the vitelline vesicle. *l*, labium; *ob*, labrum and mouth; *bn*, nervous band.

*Fig. 4.* Section a little below the mouth. *ch*, chelicerae; *æ*, oesophagus; *mmm*, the three superficial parts of the germinative bands carried on in the movement of the oesophagus; *gn*, cerebral ganglia.

*Fig. 5.* Section at the level of the labium; the nervous bands, *bn*, are still adherent to the blastoderm. *ch*, chelicerae; *l*, labium; *gn*, cerebral ganglia; *m*, as in fig. 4; *bn*, nervous bands.

*Fig. 6.* Diagram of the musculature in the thoracic region (theoretical). *m*, central musculature; *m'*, peripheral musculature; *cd*, digestive tube; *gn*, ventral ganglia; *ex*, space in which the stomachal caeca will be formed.

XVII.—*The Spiral Character of Cœlenterate Development.*

By Prof. JOHN YOUNG, University of Glasgow.

IN the Anthozoa fundamental numbers have been recognized—four for the *Cerianthus* group, six for the Stone Corals, eight for the Alcyonarians. Mereschkowsky considers the fundamental number for the Hydrozoa to be two (Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 220). Gegenbaur speaks of the tentacles as varying so that “we cannot suppose that the secondary axes are definitely differentiated.” Hæckel refers the Cœlenterate type to an imaginary six-sided pyramid. Metschnikoff and Mereschkowsky have stated the mode of development of the tentacles among the Hydroida in such fashion as to give support to the view that the partition of the Cœlenterates may be explained by analogy of the floral axis in phænogamous plants. The septa of the Anthozoa are developed in successive cycles, and symmetrically with reference to the bilateral symmetry, of which the young and even the adult stage give evidence. Huxley, following Lacaze-Duthiers, gives (‘Manual of the Invertebrates,’ p. 158) the following formula for the chambers of the hexamerous Anthozoon :—

$$\begin{array}{ccccccc} & C & E & & F & D & B \\ A & & & & & & A' \\ & C & E & & F & D & B \end{array}$$

Mereschkowsky shows that the partition of the reproductive sacs in the gonophore of *Monobrachium* takes place similarly in paired fashion, the bilateral symmetry being there also not lost sight of. As the later septa are successively shorter than those immediately preceding, it appears as if the radiate appearance of the Cœlenterata were due, not to the production of equivalent antimeres round a common centre, but to the shortening of an axis which had given off successive pairs of buds, the last pairs being represented on the shortened axis by the septa of least development. Whether the shortened axis is raceme or corymb depends on the development of the reproductive organs, on the order in which they reach maturity on the free margin of the mesenteries. The formula quoted above seems to be the expression of the spiral development. Any one who follows the development of the tentacles of a well-fed *Hydra* may see that the order of their appearance is not irregular, but that it follows a definite rule. No doubt the view here proposed has occurred to other anatomists; but as it has not, to my knowledge, been published, I now seek to put it on record as a protest, were it nothing more, against the geometric method of classifying animal forms.

XVIII.—*New Species of Coleoptera belonging to the Families Lycidæ, Zophosinæ, Lepturinæ, and Glaucitinæ.* By CHARLES O. WATERHOUSE.

THE species here described are in the British-Museum collection, with the exception of the *Nosoderma*, which is in Colonel Shelley's possession. It is with great reluctance that I place this last insect from East Africa in the genus *Nosoderma*, which has hitherto been considered to be properly American. I do not, however, find sufficient characters upon which to found a new genus.

**Lycidæ.**

*Lyropæus biguttatus*, n. sp.

Fulvo-ochraceus, opacus, dense brevissime pilosus; corpore subtus antennarumque articulis apicalibus nigris, singulis elytris gutta fusca notatis.

Long.  $5\frac{1}{2}$  lin.

Differs from *L. fallax*, Walker (Ann. & Mag. Nat. Hist. 1858, ii. p. 281; Waterhouse, Illustr. Typ. Coleopt. Brit. Mus., pt. i. p. 78, pl. xviii. fig. 4), in being of a more sandy yellow, and in having the legs and the antennæ (except the two or three apical joints) also sandy yellow. Each elytron, moreover, instead of having an apical black band, has only a small dusky spot at some distance from the apex.

*Hab.* Malabar.

The genus *Lyropæus* was proposed by myself (Trans. Ent. Soc. 1878, p. 105) for *Lycus fallax*, Walker. The present species, although differing chiefly in colour, is, I think, undoubtedly to be considered distinct. The sides of the thorax are a little sinuous, which makes the posterior angles appear more diverging; but it is not safe to give this as a specific character without having a series of specimens. Mr. F. Moore has kindly presented the British Museum with one of the specimens from his collection.

*Ditoneces obscurus*, n. sp.

Fusco-niger; thoracis limbo elytrisque ferrugineis, his fortiter punctato-striatis. ♀.

Long. 4 lin.

Relatively rather broader than any described species. It most nearly approaches *D. pubicornis*, Walker (see Waterhouse, Illustr. Typ. Coleopt. Brit. Mus., pt. i. p. 32, pl. vii. fig. 9), but is rather broader, and the colour of the margins

of the thorax and the elytra is a dull rusty brown. The antennæ are less strongly dentate than in the female of that species. The thorax is shining, rather strongly punctured within the incrassated margins, more transverse than in *D. pubicornis*, less rounded in front; and the posterior angles are not directed outwards. The elytra are parallel, strongly striated, the striæ rather distinctly and very strongly punctured; the interstices are very narrow; the pubescence is very dense and fine, but not so long as in *D. pubicornis*.

*Hab.* Malabar.

A single example recently received from the East-India Museum.

### Zophosinæ.

#### *Nosoderma cordicolle*, n. sp.

Nigrum, dense sabulosum; thorace cordato, lateribus obtuse quadridentatis; elytris infra humeros thorace latioribus, postice angustatis, fortiter subseriatim punctatis, tuberculis obtusis sex instructis, marginibus obtuse dentatis.

Long. 7 lin.

This species somewhat resembles *N. furcatum*, Kirsch. Densely covered with dirty brown sand-like scales. Thorax a little longer than broad, somewhat rounded in front, narrowed towards the base, with four obtuse teeth on the margin; the surface is uneven, impressed on the disk before and behind the middle, and with a slight double prominence in the middle of the front margin. The elytra are broadest a little way from the base, narrowed posteriorly, with several obtuse teeth or projections on the margin, arranged, four small ones around the shoulder, two (close together) about the middle, another just behind these, a large one some way from the apex, another smaller one near the apex, and a small one close to the suture; each elytron has several round, obtuse nodules, the largest of which is just before the posterior declivity. The prosternum is very broad, with a transverse impression in front, declivous posteriorly. The mesosternum is moderately broad, sloping. The intercoxal process of the abdomen is very broad and quadrate.

*Hab.* Usambala Hills, East Africa.

The general appearance of this interesting species is somewhat that of *N. furcatum*; but the form of the sterna and the broad intercoxal abdominal process are more like those of *N. diabolicum*. The antennæ are nearly those of *furcatum*; but the eleventh joint appears to be lost in the apex of the tenth. The tarsi are cylindrical, as in *furcatum*; but the pubescence below is not so long; they are not channelled as in *diaboli-*

*cum*. The thorax has on each side below a broad oblique impression for the reception of the antennæ.

I have only seen a single specimen of this species, in Colonel Shelley's collection.

### Lepturinaæ.

#### *Sagridola quinquemaculata*, Waterh.

This species was described by myself from a female example\*. A male in very imperfect condition has lately come into my hands. It differs from the female in having the posterior femora much incrassated and furnished beneath near the apex with a tooth; the anterior tibiæ are much stouter than in the female, and are densely clothed beneath with golden pubescence. Nearly the whole basal portion of the elytra is yellowish, clothed with bright yellow pubescence, but having a black spot on the shoulder, a second behind the shoulder, and one common to both elytra below the scutellum. This coloration is more probably a variation than a sexual character.

The specimen is from Antananarivo.

### Glaucitinaæ.

#### *Iresioides sericeovittata*, n. sp.

*Picea*, nitida; thorace vittis quatuor aureo-sericeis notato; elytris ad apicem singulatim rotundatis, sutura, vitta mediana marginæque laterali aureo-sericeis.

Long.  $11\frac{1}{2}$  lin.

This species differs from all the species known to me in having the elytra separately rounded at the apex and not truncated; the antennæ are, moreover, less slender; but these differences being less pronounced when compared with the smaller species of the genus, I think it best at present to associate this species with them. Head with a raised median line above; this and the front of the head coarsely punctured, the rest clothed with yellow pubescence; the antennal tubercle incrassated round the base of the antennæ in front, a little elevated on the inner side. Antennæ rather stout, one fourth longer than the whole insect in the male, reaching a little beyond the middle of the elytra in the female, reddish pitchy, the apices of the joints nearly black; the basal joint strongly punctured. Thorax scarcely as broad as long, a very little narrower in front than before the base, slightly constricted before the front and before the base, coarsely punctured, and with some transverse rugæ, with four impressed longitudinal

\* Ann. & Mag. Nat. Hist., 1875, xv. p. 414.

stripes, which are filled with yellow silky pubescence. Elytra at the base a little broader than the thorax, and nearly three and a half times as long, regularly attenuated posteriorly; each elytron with three yellow silky stripes, the middle one impressed at the base, not quite extending to the apex of the elytron.

*Hab.* Madagascar, Fianarantsoa.

XIX.—*Note on the Occurrence of Pedicellaster (Sars) in the Far North.* By W. PERCY SLADEN, F.L.S., F.G.S.

IN the "Report on the Echinodermata collected during the Arctic Expedition, 1875-76" (Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 449), a starfish obtained in Discovery Bay (lat. 81° 41' N., 25 fathoms) and off Cape Frazer (lat. 79° 44' N., 80 fathoms) was described under the name of *Asteracanthion palæocrystallus* (l. c. p. 455).

Owing to the very marked characters presented by this form, it was not without considerable hesitation that the species was classed as an *Asteracanthion*, and then only on account of extreme unwillingness to burden the nomenclature of Asterozooids with an additional generic term. Subsequent study, however, of Captain Feilden's specimens and also of Sars's original description and figures of *Pedicellaster typicus*\* (which the writer had not previously seen) leaves no doubt that the form above mentioned ought to be referred to Sars's genus.

*Pedicellaster* is characterized by the true biserial arrangement of ambulacral sucker-feet, the more or less regularly quadrate arrangement of the ossicles composing the abactinal network, the isolated spinelets borne mainly at the decussations, the general character of the spinulation together with the fact that every appendage of the body is invested with a thick semitransparent cuticular membrane, and, above all, by the presence of *pedicellariæ forcipiformes* ("*pédicellaires croisés*," Perrier) without the usual accompaniment of *p. forcipiformes*—an occurrence unknown in any other genus. The *pedicellariæ* also are of extraordinary size, being but little less than the dorsal spinelets, and stand isolated upon the membrane that stretches over the intermediate spaces of the calcareous network of the body-frame, their form at the same time being undoubtedly characteristic.

\* Oversigt af Norges Echinodermter, pp. 77-84, pl. ix. figs. 7-17, pl. x. figs. 1-10.

In each of the above particulars the specimens in question accord exactly with the diagnosis given by the eminent Norwegian naturalist. Specifically, however, *Pedicellaster palaeocrystallus*, nobis (for such it should accordingly be written), differs unequivocally from *P. typicus*, Sars (the only representative of the genus hitherto known), in the general size, proportions, and habitus of the starfish, as well as in the form of the pedicellariæ and spinelets. *P. palaeocrystallus* is of larger size; and the length of the arm-radius in proportion to that of the disk (about 5 : 1) is less than in *P. typicus*, in which it is  $6\frac{1}{2}$  or 6 : 1; the contour of the arms is also different in our form, being more tumid on the inner third and much more attenuated on the remaining outward portion of the ray; the dorsal spinelets are decidedly radio-laminate and somewhat expanded at the tip, instead of being conical as described in *P. typicus*; and the shaft of the ambulacral spinelet is denticulate; whilst the pedicellariæ in the present species differ in being of even larger size and having the contour of the jaws considerably swollen out about the outer third and then tapering rapidly towards the extremity, which is somewhat truncate.

Other minor differences occur; and these, together with figures, will be recorded in the memoir on Arctic Echinodermata, in course of preparation by Prof. P. Martin Duncan and the writer.

The great rarity of the genus *Pedicellaster* and the interest attaching to its occurrence in such high latitudes may be urged in justification of the present advance-note upon the subject.

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XX.—*On a Spine* (Lophacanthus Taylori, *mihi*, *nov. gen. et spec.*) *from the Coal-measures of Northumberland.* By THOMAS STOCK, of the Natural-History Department, Museum of Science and Art, Edinburgh\*.

AMONGST a parcel of fish-remains sent me a few months ago by Mr. Joseph Taylor of Shire Moor, Northumberland, was a spine which Mr. Taylor said he believed was new. After a careful study of the specimen, and after consulting all the literature of the subject accessible to me, I came to the conclusion that the spine was not only specifically new, but must be regarded as the type of a new genus.

*Description.* The spine, as I received it, was in three fragments: the two upper were partially imbedded in the matrix;

\* Read before the Edinburgh Geological Society, December 1879.

the lower was free. A small piece of about 7 millims. had been removed by Mr. Taylor, with the intention of preparing a microscopic section from it. The length of the spine as it exists is 18·4 centims. ; in its perfect condition it was considerably longer. The base is broken short off at what must have been an appreciable distance above the point at which the spine entered the body of the fish, as no trace of the inserted portion remains. Its greatest diameter, which is at the base, is 9 millims. It curves gently backwards ; the curvature is greater towards the point than towards the base. The apex itself is rather finely pointed and enamelled with ganoine. The ornament consists of numerous fine, longitudinal, slightly irregular striæ ; it covers the whole of the existing surface with the exception of the tip. The grooves are narrower than the ridges, and smooth. Fracture shows that the pulp-cavity occupies the greater length of the spine. It is circular in shape, and, as is usually the case, is placed a little posterior to the median line. Its walls are thick. The anterior aspect is very convex throughout. On the posterior aspect is a prominent ridge, sloping to the left lateral margin at an average inclination of 35°. Between the summit of the ridge and the right lateral margin there is a groove, extending from the tip to the base. The middle third of the ridge is very gently undulated. In the groove are a few irregular pits ; two of them may be seen about halfway between the point and the base, four near the apex. At first I supposed that these pits were the

Fig. 1.

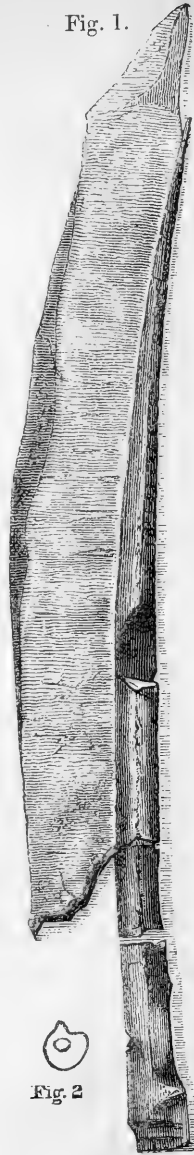


Fig. 2

Fig. 1. *Lophacanthus Taylori*, mihi ;  $\frac{3}{4}$  nat. size. In the Collection of Mr. Joseph Taylor.

Fig. 2. Ditto ;  $\frac{3}{4}$  nat. size, cross section.



scars of denticles that had become detached; but the most careful examination of the counterpart of two of the largest of them failed to reveal the slightest trace of tubercular or denticular structure.

*Comments.* The base of the spine is unfortunately wanting, so that it is impossible to say at what angle it was inserted in the body of the fish. From its great length and slenderness it may be conjectured that it was set at a very low angle, or that it was supported for the greater part of its length by a strong cartilaginous structure; it seems weak as a defensive weapon, compared with what was probably the large size of the fish.

*Relations and Differences.* In discussing its relations to genera previously described, it will be enough to notice at length two only, viz. *Leptacanthus* and *Orthacanthus*, both established by Agassiz. Agassiz's *Leptacanthus* was founded upon Jurassic specimens. *L. longissimus* from Caen was doubtfully put by him in the genus. He says "Je le signale plutôt à l'attention des paléontologistes que je n'espère en donner une description satisfaisante." He is doubtful as to the serration and as to the ornament. Until the spine is better known it would be unwise to say much about it. If Agassiz's account of it is correct, Mr. Taylor's specimen differs from it by important characters. *L. longissimus* is finely serrated on the posterior margin, compressed, and shows in cross section a concave posterior area. Two spines from Carboniferous rocks have been referred to *Leptacanthus* by M'Coy (Brit. Pal. Fossils, p. 633); both, however, differ by important characters from Mr. Taylor's specimen.

Curved spines have been referred to *Orthacanthus* by J. S. Newberry (Pal. Ohio, vol. i. p. 332). He believes the straightening is due to pressure. *Orthacanthus* appears to be rare in the British Coal-measures, but is usually, when referred to, described as straight. Whether curved or straight, the generic distinctness of the specimen I am describing will not, I think, be affected. The structure of the posterior area, the absence (?) or, if it may be said to exist, the peculiar nature of the denticulation, and the general facies of the spine separate it from that genus. The same assemblage of characters separates it also from *Phricacanthus*, a spine described by Mr. J. W. Davis, F.G.S. (Q. J. G. S., May 1879).

I have no data by which to connect it with teeth or other remains of diagnostic value. The specimen appears to be unique. Until discovery throws light upon its true affinities it must remain as the type of a new genus, which I propose

to call *Lophacanthus*\*; and to it I add the specific name of *Taylori*, in honour of the discoverer.

*Horizon and Locality.* Shale above the Low Main Seam, Newsham, Northumberland.

## XXI.—*On the Nomenclature of Polyzoa, Busk.*

*To the Editors of the Annals and Magazine of Natural History.*

GENTLEMEN,—My friend Mr. A. W. Waters, F.G.S., has lately referred (in your Number for January 1880) to my use of the word “Polyzoa” (in Dixon’s ‘Geology of Sussex,’ new edition, pp. 200 and 311) for the *group* as determined by Mr. Busk, F.R.S., instead of for the *zooïd* as applied by Thompson. I am sorry that I did not write as accurately and clearly as might have been. Instead of “POLYZOA, Thompson,” I should have written “POLYZOA, Busk;” and I ought not to have stated that “the *Polyzoa* were first defined by Dr. J. V. Thompson,” &c., but that, *following up Thompson’s researches, Mr. Busk completed the determination of the group.* In my own words, I repeat that “group-names are indications of advancing scientific knowledge, and not to use the best is to keep science back.” Further, “the published name of a species is (or ought to be) not only the established appellation of a distinct form in nature, but also the registered evidence of the successful labour and acumen of its discoverer and describer,” whilst the complete mastery of such natural groups as genera &c. comes with time.

On another point,—if your readers please to refer back to the Ann. & Mag. Nat. Hist. vol. vii. no. 44, June 1841, pp. 301 *et seq.*, they will find a transcript of Ehrenberg’s finished classification from the Trans. Berlin Acad. for 1838, when his “Bryozoa” comprised four orders, the first of which consists of the “Polythalamia;” and all of these, except *Lunulites*, *Cupularia*, and *Flustrella*, are FORAMINIFERA. Consequently Mr. Waters has to take this matter into his further consideration. For my part I am quite willing to accept Mr. Busk’s determination of the group (see Ann. & Mag. Nat. Hist. ser. 2, vol. x. p. 352, 1852; Cat. Polyzoa Brit. Mus.; and Monogr. Pal. Soc., Polyzoa of the Crag, &c.) as the latest and the best; and I shall not trouble you with any further correspondence on the subject.

Your obedient Servant,

T. RUPERT JONES.

Camberley, Surrey,  
Feb. 10, 1880.

\* λόφος = a ridge.

XXII.—*On a small Collection of Lepidoptera from Western India and Beloochistan.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE series of *Lepidoptera* of which the following is a list was obtained by Major Charles Swinhoe, for the most part from the Neilgherries and from Kurrachee\*, but a few from Belgaum (Bombay Pres.), and three or four from Beloochistan.

With the exception of *Pyrgus evanidus*, the species from the last-mentioned locality do not differ from specimens previously obtained in North-western India.

### Nymphalidæ.

#### DANAINÆ.

##### 1. *Danaïs dorippus*, Klug.

One example. . Kurrachee ; September 1879.

#### SATYRINÆ.

##### 2. *Hipparchia parisatis*, Kollar.

Three examples. " Much," Bolan Pass, Beloochistan ; August.

#### NYMPHALINÆ.

##### 3. *Charaxes fabius*, Fabricius.

One specimen. Neilgherries.

#### ACRÆINÆ.

##### 4. *Telchinia vesta*, Fabricius.

One specimen. Neilgherries.

### Lycænidæ.

#### LYCENINÆ.

##### 5. *Anops phædrus* ♂, Fabricius.

One specimen. Belgaum (1879).

##### 6. *Lycæna karsandra*, Moore.

Kurrachee, July.

Major Swinhoe sent thirty-three examples of this species

\* Where Major Swinhoe is at present stationed.

in a small pill-box; but unfortunately they were attacked by two specimens of a little beetle (*Tribolium ferrugineum*), which, by the time they arrived, had destroyed or damaged every specimen; only three retained the thorax intact so as to render it possible to set them out.

7. *Lycænesthes ubaldus*, Cramer.

Three specimens. Kurrachee, August.

Papilionidæ.

PIERINÆ.

8. *Teracolus protractus*, Butler.

Two specimens. Hubb River, Beloochistan, August.

9. *Teracolus puellaris*, Butler.

One specimen (♂). Hubb River, Beloochistan; August.

This prettily little species was evidently taken for a small example of the following, from which, however, it may readily be distinguished by the much broader black border of the secondaries. Mr. Moore received a long series of *T. puellaris* in a collection from Kutch (but *T. vestalis* did not come with it); it occurs also in the Punjab.

10. *Teracolus vestalis*, Butler.

Three specimens. Hubb River, Beloochistan and Kurrachee; August.

One male example is labelled "Muggin Peer." Is this Magar Pir, Kurrachee? The female is from Kurrachee.

The male of *T. vestalis* was described from a Scinde example, and the female from one taken at Agra, N.W. Punjab: the capture of it in Beloochistan therefore slightly extends its known range.

11. *Teracolus dirus*, Butler.

This species was described and figured from an albino female in Mr. Moore's collection; the ordinary form has the apical area of the primaries above broadly carmine, being, in fact, very similar to *T. dulcis*, but larger, the male with broader black internal border to the apical area; the basal area of the wings darker in both sexes, and with distinct blackish spots at the outer extremities of the first and second median branches on the under surface.

Four pairs. Kurrachee, July 1879.

Judging from an example of *T. dulcis* ♀ recently received

from the India Museum, and which closely agrees in general characters (in the size of the marginal spots of secondaries, for instance, as well as in expanse) with the male which I figured, I have little doubt that the female figured by me is an ordinary *T. dirus*, and not *T. dulcis* at all; it agrees well with Major Swinhoe's female specimens. Both species occur at Scinde.

12. *Belenois mesentina*, Cramer.

One pair. "Much," Bolan Pass, Beloochistan; October.

PAPILIONINÆ.

13. *Papilio doson*, Felder.

One example, probably from the Neilgherries; locality not noted.

Hesperiidæ.

14. *Pyrgus evanidus*, n. sp.

Above extremely like *P. galba*, Fabr. (*P. superna*, Moore), but distinctly greyer in colour, the ground-colour being black instead of brown; below greyer and paler, the secondaries being very faintly tinted with yellowish, the central white belt broken up into three spots, of which the two lower ones are contiguous, instead of forming one continuous band across the wings; other markings similar. Expanse of wings 11 lines.

Two specimens. Sao, Hubb River, Beloochistan; November.

15. *Plesioneura ambareesa*, Moore.

One male. Matheran.

Chalcosiidæ.

16. *Chalcosia affinis*, Guérin.

Two specimens from Belgaum, and two from the Neilgherries.

Lithosiidæ.

HYPSINÆ.

17. *Damalis strigivenata*, Butler.

Belgaum.

Ennomidæ.

18. *Hyperythra Swinhoei*, n. sp.

Above ochreous buff, minutely and sparsely speckled with

brown; primaries with traces of two parallel slightly arched discal brown lines, the outer one limited externally by two diffused brown patches, the larger one extending from costa to lower radial, the lower one on second median interspace; a minute indistinct brown discocellular spot: secondaries with traces of two closely approximated blackish abbreviated discal lines from costa to second median branch, the outer line interrupted near costa by two large rounded blackish spots: body yellow, sericeous. Wings below bright yellow, sparsely sprinkled with fine abbreviated purplish-brown striæ; external area tinted with saffron-yellow and limited internally by a slightly sinuated purplish-brown line; discocellular dots and an ill-defined line just beyond the cell of secondaries purplish brown: body below bright yellow in the centre, tinted with saffron-yellow at the sides. Expanse of wings 1 inch 4 lines.

One male. Kurrachee, October 1879.

#### Geometridæ.

##### 19. *Nemoria pruinosa*, n. sp.

Sea-green, densely irrorated with silvery white; body pale yellow, antennæ testaceous. Wings below silvery white, slightly tinted in front with green; body below cream-coloured. Expanse of wings  $7\frac{1}{2}$  lines.

One male. Kurrachee, September 1879.

#### Macariidæ.

##### 20. *Tephrina strenuataria*.

*Macaria strenuataria*, Walker.

Three examples. Kurrachee, May and September.

#### Noctuidæ.

##### 21. *Graphiphora c-nigrum*.

*Phalæna-Noctua c-nigrum*, Linn.

Two specimens. Neilgherries.

#### Orthosiidæ.

##### 22. *Orthosia erubescens*, n. sp.

Primaries above shining pinky brown; base crossed by small black dots; discoidal spots imperfectly represented by interrupted black outlines; discal lines barely indicated by indistinct greyish curved stripes; costa towards apex suffused with blackish: secondaries pale sericeous greyish brown,

slightly cupreous upon the margin, fringe whitish at base : thorax pinky brown, vertex of head and front of palpi white ; abdomen greyish brown, with testaceous lateral and anal tufts. Wings below shining chalky white, with pinky-brownish costal borders ; discocellular stigma and an abbreviated discal line grey ; primaries with the discoidal area greyish : body below testaceous, washed at the sides with dull reddish. Expanse of wings 1 inch 3 lines.

One male. Neilgherries.

### Hadenidæ.

23. *Euplexia albovittata*, Moore.

One specimen. Neilgherries.

### Ommatophoridæ.

24. *Nyctipao lætitia*, Butler.

One example. Belgaum, 1879.

### Ophiuidæ.

25. *Grammodes stolidæ*, Fabr.

Two specimens. Kurrachee, July and October.

### Remigiidæ.

26. *Remigia frugalis*, Fabr.

Three specimens. Kurrachee, October.

### Thermesiidæ.

27. *Azazia rubricans*, Boisd.

Four examples. Kurrachee, October.

One specimen is considerably darker than the three others.

### Hypenidæ.

28. *Hypena laceratalis*, Walker.

Mulleer near Kurrachee, November.

29. *Docela affinis*, n. sp.

Closely allied to *D. vetustalis*, from which it principally differs in the darker central band of primaries and the broader yellow band of secondaries : grey ; wings crossed by an irregular blackish band, interrupted upon the secondaries, which it traverses at basal third, angulated and central upon primaries ;

a yellow discal band with blackish external margin, very slender upon primaries, but widened into an elongated triangular patch upon the secondaries, bounded outwardly upon the primaries by three dark brown spots and towards apex of secondaries by a large dark brown patch; external border bronzy, fringe varied with white; primaries with a small red-brown reniform spot with pale border. Under surface sordid white; wings with blackish apical patches, fringe snow-white at apex. Expanse of wings 11 lines.

One example. Kurrachee, October.

There are also two specimens in Mr. Moore's collection. This genus much resembles in marking the Noctuid group *Microphya*, but differs in its much longer and thicker palpi.

### Asopiidæ.

#### 30. *Hymenia fascialis*, Cramer.

Three specimens. Kurrachee, June and October.

### Botydidæ.

#### 31. *Botys iopasalis*, Walker.

Three specimens. Kurrachee, September and October.

#### 32. *Godara comalis*, Guénée.

Two specimens. Kurrachee, October.

### Tineidæ.

#### 33. *Alavona barbarella*?, Walker.

Matheran, May 1879.

I cannot be perfectly certain of the identification of this species, owing to the rubbed condition of the type and the difficulty of tracing the markings in any but very good specimens of this genus.

XXIII.—On a Collection of Crustacea from the Malaysian Region.—Part I. Crustacea *Oxyryncha* and *Cyclometopa*, except Telpusidea. By EDWARD J. MIERS, F.L.S., F.Z.S.

[Plate XIII.]

THE present paper, which will be continued in succeeding numbers of the 'Annals,' will contain a complete enumeration, with notes and descriptions (where needed), of the Crus-



tacea recently selected from the collection of the late Dr. P. Bleeker, the eminent ichthyologist, for the British Museum. This collection is of much interest, not merely on account of the new and undescribed species included in it, which, as was to be expected in a collection from a region so thoroughly worked, are not very numerous, but also on account of the many species it contains which have been hitherto *desiderata* to the Museum collection. Amongst these are several of the Maiioidea, and fourteen out of sixteen species of Isopoda (Cymothoidea) parasitic on fishes, described by Dr. Bleeker in his two memoirs, entitled “*Sur les Décapodes Oxyrhinques et les Isopodes Cymothoadiens de l’archipel Indien*”\*.

To avoid needless repetition I have seldom given references to the literature, except in those not unfrequent cases where I have been enabled to correct the synonyma or bring together species which appear to have been based on characters of insufficient value.

The exact localities were unfortunately not marked on all the bottles in Dr. Bleeker’s collection; but those which were not more particularly labelled were marked as containing “*Crustacea Indo-Archipelagica*,” and therefore no doubt can be entertained of the Malaysian habitat of all the species.

#### OXYRHYNCHA *vel* MAIOIDEA.

##### *Doclea brachyrhynchus*.

*Doclea brachyrhynchus*, Bleeker, Act. Soc. Indo-Néerl. ii. p. 14 (1857).

*Doclea sebæ*, Bleeker, *l. c.* p. 13 (1857), junior.

An adult male, agreeing well with Bleeker’s description, is in the collection, without special locality. A second male example agrees with the description of *Doclea sebæ*; and a comparison of the two specimens leaves little doubt in my mind that this latter species must be united with *D. brachyrhynchus* as having been established upon younger examples. The only character by which *D. sebæ* is distinguished, viz. the somewhat shorter, slenderer chelipedes, with fingers meeting along their inner margins, cannot be considered of specific value.

##### *Doclea macracantha*.

*Doclea macracanthus*, Bleeker, Act. Soc. Indo-néerl. ii. p. 10 (1857).

? *Doclea microchir*, Bleeker, *l. c.* p. 11 (1857), junior?

A small male example, without special indication of locality, agrees very well with Bleeker’s description. As far as can be judged from the description, *D. microchir*, Bleeker, which

\* Acta Soc. Sci. Indo-Néerlandicæ, Deel ii (1857).

is mainly distinguished by the relatively longer spines of the carapace and shorter legs of the second pair, is not specifically distinct. Amboina is mentioned by Bleeker as the habitat of the first, and W. Sumatra (Padang) as the habitat of the second species.

*Micippa cristata* (Linn.).

Java, a fine adult male.

*Tiarinia cornigera*?

? *Pisa cornigera*, Latr. Encycl. Méth. x. p. 141 (1825).

? *Pericera cornigera*, M.-Edwards, Hist. Nat. Crust. i. p. 335 (1834).

*Tiarinia cornigera*, Dana, U.S. Expl. Exp. Cr. i. p. 110, pl. iii. fig. 5 (1852).

Carapace broadly pyriform, narrowing rapidly from the middle of the branchial region (where it attains its greatest width) to the orbits, covered with more or less conical and acute irregularly-disposed unequal tubercles; three more prominent and rounded tubercles are placed in the middle of the cardiac region, and three in a transverse series on the posterior margin. The rostrum is imperfect; but from the single spine remaining it is probable that the rostral spines were parallel to their apices, straight and shorter than the width of the interorbital part of the carapace. There is a small supra-ocular spine; the anterior legs are robust; the arm irregularly tuberculated; wrist nearly smooth; palm smooth, enlarged, compressed, longer than broad; fingers arcuate and meeting only at the apices; on the inner margin of the upper finger near the base is a small tubercle; the first ambulatory legs are considerably elongated. Length to base of rostrum 1 inch  $3\frac{1}{2}$  lines, breadth 1 inch  $2\frac{1}{2}$  lines.

Java, Karangbollong (one adult male).

The descriptions of Latreille's and Milne-Edwards's *P. cornigera* are not sufficiently detailed for me to be certain that I am right in referring the example described above to it; it is, however, probably identical with the specimen described and figured by Dana as *T. cornigera* (Cr. U.S. Expl. Exp. xiii. p. 110, pl. iii. fig. 5, 1852), although the tubercles of the carapace are apparently more numerous.

CYCLOCÆLOMA, gen. nov.

Carapace suboblong, somewhat elongated, rounded behind and slightly constricted behind the orbits, which are tubular, projecting laterally, without spines, and with a small circular opening as in many Periceridæ. Spines of rostrum very small. Basal joint of antennæ very greatly enlarged, as in *Othonia*,

the next joint enlarged but more elongated and less dilated than in that genus. Ischium-joint of outer maxillipedes small and narrow; merus-joint somewhat produced at its antero-external angle, as in *Othonia*. Anterior legs (in the male) small and slender; palm smooth and not dilated, twice as long as the fingers, which are excavated on their inner margins towards the apices, which, however, are acute. Ambulatory legs of moderate length. Postabdomen (of male) with all the segments distinct.

This interesting transitional form must be placed in the sub-family Othoniinae (as characterized in my recent revision of the Maioidea, a group hitherto restricted to the single West-Indian genus *Othonia*). From that genus it is distinguished by the more elongated carapace, which is not armed with lateral spines, the more distinct rostral spines, less dilated third antennal joints, and non-dilated anterior legs of the male. It is very distinctly related to *Criocarcinus* and *Pseudomicippe* in the family Maiidae; the inferior hiatus of the tubular orbits in *Criocarcinus*, however, is closed in *Othonia* and *Cyclocaeloma*.

*Cyclocaeloma tuberculatum*, sp. n.

(Pl. XIII. figs. 1, 2.)

Carapace armed with tubercles disposed as follows:—five tubercles, of which the median is the largest, on the front of the gastric region, and posterior to these four large rounded elevations in a median series, viz. one on the gastric, one on the cardiac, one on the intestinal region, and one on the posterior margin; there is a prominent rounded tubercle on each hepatic region, and about four on each branchial region, of which one is much larger than the rest. The spines of the rostrum are subacute and separated by a narrow median fissure. The slender palm or penultimate joint of the anterior legs about equals the arm in length, and is smooth, not compressed or dilated; the fingers are shorter than the palm. The small terminal claw of the ambulatory legs is but slightly incurved. Length  $1\frac{3}{4}$  inch, breadth 1 inch.

Amboina (an adult male).

The single example has a short series of stiff curled hairs on the front of the gastric and cardiac regions and on the sides of the branchial regions. The first free antennal joint is narrowest at base and dilated toward the distal end, where it is about half as broad as long; thus it differs markedly from the slender form of certain species of *Macrocaeloma* in the Periceridae, to which this genus bears some external resemblance. In *Macrocaeloma*, moreover, the rostrum

is always much more considerably developed, and there is a distinct spine at the end of the basal antennal joint.

*Lambrus contrarius* (Herbst).

A male and female are retained for the Museum. No definite locality was preserved; but Bleeker states that this species is not uncommon at the Moluccas. A comparison of the Malaysian examples with specimens from the Mauritius convinces me of the correctness of Bleeker's determination.

*Lambrus lamelliger*.

*Lambrus lamelliger*, White, P. Z. S. p. 58 (1847).

*Lambrus lamellifrons*, Adams and White, Zool. Samarang, Crust. p. 26, pl. v. fig. 1 (1848).

*Lambrus Rumphii*, Bleeker, Act. Soc. Indo-Néerl. ii. p. 18 (1857), nec *C. longimanus*, Rumph.

An adult male without definite locality is in the collection, which I refer to this species. The gastric, cardiac, and branchial regions are very much elevated and indistinctly tuberculated; on the branchial regions one of the tubercles is much more prominent and obtuse. The rostrum is very prominent on its upper surface; and the interorbital space is deeply concave; the anterior legs are very robust, and the anterior and posterior margins of the arm and hand are armed with prominent, rounded, obtuse tubercles, of which there are only two or three on the posterior (or outer) margin of the hand. The ambulatory legs are smooth.

The specimen from the Philippine Islands designated *L. lamelliger* in the Museum collection is of small size, and the tubercles of the carapace and anterior legs are more acute and spine-like.

Bleeker's description of *L. Rumphii* also applies to this species; but the figure of Rumph (Amboin. Rariteit. p. 16, pl. viii. fig. 3), copied by Herbst (Nat. Krabben, i. p. 252, pl. xix. fig. 106), cited by Bleeker agrees far better with specimens from the Philippines in the Museum collection, named, perhaps wrongly, *Lambrus turriger*, Ad. & White. This latter species is distinguished from the foregoing by having a long prominent spine on each of the regions of the carapace, and the subcylindrical anterior legs covered with small nearly uniform tubercles.

*Lambrus laciniatus*?

? *Lambrus laciniatus*, De Haan, Faun. Japon. Crust. p. 91, pl. xxii. figs. 2, 3 (1839).

A male, without definite locality, is in the collection. It

differs from De Haan's figure in having the spines of the posterior (or outer) margin of the palm somewhat fewer in number and broader at base, where they are almost in contact with one another; but I do not regard it as belonging to a distinct species.

*CYCLOMETOPA vel CANCROIDEA.*

*Atergatis floridus* (Linn.).

Java, Karangbollong (male and female); Amboina (young female).

*Atergatis integerrimus* (Lamarck).

Java (an adult female). Another specimen without locality is in the collection.

*Lophozozymus epheliticus* (Linn.).

Java (an adult male).

*Liomera Rodgersii*. (Pl. XIII. fig. 3.)

*Lachnopus Rodgersii*, Stimpson, Proc. Ac. Nat. Sci. Phil. p. 32 (1858); A. Milne-Edwards, Nouv. Arch. Mus. Hist. Nat. i. p. 233 (1865).

Carapace transverse, about once and a half as broad as long, smooth, glabrous, and shining, with the interregional sutures almost obsolete; the two posterior teeth of the antero-lateral margins are the only ones developed, and are very obscurely marked and obtuse. The front is somewhat produced, and is divided by a median and two lateral incisions into four lobes, of which the two median are broad and truncated, and the lateral (or inner orbital lobes) are small and dentiform. On the upper orbital margin are three small obtuse teeth (including that of the outer orbital angle); the tooth at the inner and lower orbital angle is rather prominent. The merus-joint of the outer maxillipedes is rather small and transverse; and this joint has a shallow pit on its outer surface. The anterior legs (in the male) are robust, smooth; arm or merus-joint with a series of spinules on its upper margin; carpus smooth, with an antero-internal tooth; penultimate joint or palm slightly rugose externally, and with two longitudinal and parallel grooves on its outer surface; fingers short, robust, toothed on their inner margins and with the apices not excavated. The ambulatory legs are somewhat compressed and clothed with long fulvous hairs; their merus-joints are spinulose on the upper margins. The postabdomen of the male is five-jointed, the third to fifth joints

being coalescent. Length  $8\frac{1}{2}$  lines, breadth nearly 1 inch 1 line.

This species has been hitherto known only from the very short generic definition of Dr. Stimpson, which, however, embraces all the characteristic peculiarities of the species, and which agrees exactly with the example before me, except in one point. Stimpson says (*l. c.*), "*Antennæ ut in *Carpilio*."* In the specimen now before me the antennæ are of the same structure as in *Liomera*, the basal joint being very short and united at its summit to an inferior prolongation of the front, and not, as in *Carpilius*, joined to the front along its inner margin. I have little doubt that Stimpson erroneously wrote *Carpilius* for *Liomera*, as he does not say that *Lachnopus* is distinguished from *Liomera* by any peculiarity in the structure of the antennæ.

I do not think that *Lachnopus* is generically distinct, as Milne-Edwards has described a *Liomera* (*L. longimana*) with hairy ambulatory legs.

### *Actæa Rüppellii*.

*Ægle Rüppellii*, Krauss, Südafrik. Crust. p. 28, pl. i. fig. 1 (1843).

? *Ægle rugata*, Adams and White, Zool. Samarang, Cr. p. 43, pl. viii. fig. 5 (1848).

*Actæa Rüppellii*, A. M.-Edwards, N. A. Mus. Hist. Nat. i. p. 270 (1865); Hilgendorf, Monatsb. Akad. Wissensch. Berlin, p. 787 (1878).

*Actæa rugata*, A. M.-Edwards, *l. c.* p. 269 (1869).

An adult male is in the collection, without definite locality, agreeing exactly with the figure of Krauss, and also with specimens in the Museum collection from the Mauritius. It is extremely probable that the *Ægle rugata* of White is, as noted by Hilgendorf, not specifically distinct, although the type specimen from the Philippines in the Museum collection has the lobules of the carapace covered with more numerous and smaller granules, and the chelipeds and legs are more densely hairy. But I see some reason to doubt the correctness of Hilgendorf's identification of Heller's *A. Kraussii* with the foregoing.

In specimens from Egypt in the Museum collection, which I refer to *A. Kraussii*, the carapace is wider in proportion to its length and less distinctly granulated. Both carapace and legs are much more densely pilose.

### *Menippe (Myomenippe) panope*.

*Cancer panope*, Herbst, Nat. Krabben, iii. p. 40, pl. liv. fig. 5 (1801).

*Cancer Hardwickii*, Gray, Zool. Miscell. p. 40 (1831).

*Menippe granulosa*, Strahl, Arch. f. Nat. xxvii. p. 105 (1861); A. M.-Edwards, Ann. Soc. Entom. France, vii. p. 275 (1867)?

*Menippe panope*, v. Martens, Arch. f. Nat. xxxviii. p. 87 (1872).

*Myomenippe duplicidens*, Hilgendorf, Monatsb. Akad. Wissensch. Berlin, p. 796 (1878), footnote.

Java (an adult female of large size); Amboina (a male of smaller size).

The type of Gray's *C. Hardwickii* is from the Indian Ocean.

It is not without considerable hesitation that I have united the several species cited above under the heading of *C. panope*. The identification of Strahl's *Menippe granulosa* with Herbst's *C. panope* was made by Von Martens, after examination of the typical specimens; and the diagnosis of the latter author, as also the description by Hilgendorf of *M. duplicidens*, apply very well to the type of Gray's *C. Hardwickii* and the other specimens of this species in the Museum collection. The granulation of the sides of the carapace and bases of the fingers is somewhat less distinct in the specimens from Java and Amboina than in Gray's type; and it is possible that a larger series of specimens might establish a complete transition to the following species.

*Menippe (Myomenippe) Legouilloui*.

*Menippe Legouilloui*, A. M.-Edwards, Ann. Soc. Entom. France, vii. p. 274 (1867).

A male individual, without definite locality, is in the collection. It is distinguished mainly by the lesser prominence of the tubercles of the carapace and the absence of granulations on the upper surface of the wrist, palm, and base of mobile finger.

There is also a specimen from Swan River in the Museum collection.

*Myomenippe Fornasini*, Hilgendorf (Monatsb. Ak. Wissensch. Berlin, p. 795, 1878), from Mozambique, is evidently very nearly allied to this species; but I should hesitate to unite the two without comparison of specimens.

*Epixanthus dentatus*.

*Panopeus dentatus*, White, Proc. Zool. Soc. p. 226 (1847); Adams and White, Zool. Samarang, Crust. p. 41, pl. xi. fig. 1 (1848).

*Epixanthus dilatatus*, Man, Notes from the Leyden Museum (no. xix.), p. 58 (1879).

Java (an adult male and female).

These specimens agree very well with Mr. Man's description of *E. dilatatus* (also founded on specimens from Java), and with the types of *Panopeus dentatus*, excepting only that they present no trace of the variegated coloration of the

carapace, which is excellently preserved in White's specimen. The figure given by White, although very characteristic, represents the chelipedes in such a position as to conceal the characteristic tuberculation of the mobile finger of the larger hand and the slenderness of the fingers of the smaller one, on which account, perhaps, Mr. Man did not suspect their identity with his species.

*Carpilodes cinctimanus*.

*Carpilius cinctimanus*, White, Append. Juke's Voy. Fly, Crust. p. 336, pl. ii. fig. 3 (1847); Adams and White, Zool. Samarang, Cr. p. 37, pl. vii. fig. 4 (1848).

*Liomera cinctimana*, A. M.-Edw. Nouv. Arch. Mus. Hist. Nat. i. p. 219 (1865), ix. p. 176, pl. v. fig. 4 (1873).

? *Liomera lata*, Dana, Cr. U.S. Expl. Exp. xiii. p. 161, pl. vii. fig. 6 (1852).

A young male is in the collection, without definite locality. As has been already noted by Prof. A. Milne-Edwards, in the young of this species the hand is without the black cincture, and the fingers are whitish.

*Actæodes tomentosus* (M.-Edwards).

A male example is in the collection, without definite locality.

*Zozymus æneus* (Linn.).

Java (a young male).

*Chlorodius niger* (Forskål).

New Guinea (one female).

*Leptodius exaratus*, var. *sanguineus* (M.-Edw.).

Java (an adult male).

The remarks made by me upon this species in Proc. Zool. Soc. 1877, p. 134, on specimens from Duke-of-York Island, apply equally well to the Javan example.

*Pilumnus vespertilio*.

*Cancer vespertilio*, Fabr. Ent. Syst. ii. p. 463 (1793), Suppl. p. 338 (1798).

*Pilumnus vespertilio*, Leach, Trans. Linn. Soc. xi. p. 321 (1815); M.-Edw. Hist. Nat. Crust. i. p. 418 (1834); Cr. in R. A. de Cuvier, Atlas, pl. xiv. fig. 3; Dana, U.S. Expl. Exp. xiii. Cr. i. p. 236 (1852); A. M.-Edw. N. Arch. Mus. Hist. Nat. ix. p. 242 (1873); Hilgendorf, Monatsb. Akad. Berlin, p. 793 (1878).



*Pilumnus ursulus*, Adams and White, Zool. Samarang, Cr. p. 45, pl. ix. fig. 6 (1848); Hess, Arch. f. Nat. p. 137, pl. vi. fig. 2 (1865).

*Pilumnus mus*, Dana, Pr. Ac. Nat. Sci. Phil. p. 82 (1852); U.S. Expl. Exp. xiii. Cr. i. p. 240 (1852).

Java (a female).

The hairs covering the body of this species vary from a deep brown to a fulvous or cinereous hue. The small tooth of the antero-lateral margins, situated anterior to and on a lower level than the first of the proper antero-lateral marginal teeth, and which is mentioned both by Milne-Edwards (in *P. vespertilio*) and Dana (in *P. mus*), is not invariably developed. This is a very common and generally distributed inhabitant of the Australian, Malaysian, and Pacific seas.

Kossmann (Zool. Ergebn. des rothen Meeres, Brachyura, p. 38, 1877) has recently subdivided the genus *Pilumnus* into three subgenera, based on characters derived from the presence or absence of fissures in the upper orbital margin. *P. vespertilio* belongs to the subgenus *Pilumnus* as restricted by him, as there are usually indications of two fissures in the upper orbital margin. I doubt, however, the constancy of these characters, or their validity as a means of separating the species, much as the genus *Pilumnus* requires subdivision into smaller groups.

*Pilumnus Bleekeri*, sp. n.

Carapace convex, with the antero-lateral margins shorter than the postero-lateral, and armed with five rather long spines (including the extraorbital spine); the spine next to this is placed on the subhepatic region. The body and legs are rather thinly clothed with long fulvous hairs; the front is divided by a rather wide and deep fissure into two truncated lobes. The orbits are armed with a series of prominent spinuliform teeth on their lower margins; but the upper margin is only minutely granulated, and is without fissures. The anterior legs are robust; the arm has three teeth on its upper margin; the wrist and palm are hairy; the palm is covered with rather irregularly-disposed granules on its outer surface, which toward the upper margin tend to become spinuliform; toward the lower margin the surface is smooth; but there is a line of granules on the lower margin of the hand. The fingers are short and thick, denticulated on their inner margins; the upper is granulated above at its base; the lower margin of the immobile finger forms a straight line with the inferior margin of the palm. Length 9 lines, breadth 11 lines.

New Guinea. Two males are in the collection. In the

larger, the fingers are of a chocolate-brown colour; in the smaller they are nearly colourless.

The truncated frontal lobes, with the armature of the carapace and chelipedes, apparently suffice to distinguish this species from its very numerous congeners. Many of the species of *Pilumnus*, however, are insufficiently known, and the genus is one which greatly needs a thorough revision. *P. Bleekeri* somewhat resembles *P. actumnoides*, A. Edw., which is represented as having the antero-lateral margins armed with more numerous teeth, and the hands more granulated on their external surface.

*Pilumnopeus granulatus*, sp. n.  
(Pl. XIII. figs. 4, 5, 6.)

Carapace transverse, about once and a half as broad as long, and covered with small regularly disposed granules, which tend to become obsolete toward the posterior margin. Front rather prominent, divided by a small triangular median sinus into two lobes, the anterior margins of which are straight and rather oblique. Posterior to the frontal lobes, and occupying the interorbital space, are two small prominences. The antero-lateral margins are armed with five teeth (including the outer orbital tooth, which is very small); the orbital margins are without fissures, and the internal orbital hiatus is occupied by the outer antennæ, the basal joint of which is small and does not nearly reach the front. The anterior legs (in the female) are robust, the arm very short and smooth; the wrist regularly and evenly granulated on its outer surface, but without a spine at its antero-internal angle; palm covered on its outer surface with numerous granules; dactylus also granulated to within a short distance of its extremity; both this and the lower joint are strongly denticulated on their inner margins. Ambulatory legs slightly compressed and nearly smooth. Abdomen of female 7-jointed.

Indo-Malayan Region. One specimen of this very pretty little crab is in the collection; but the precise locality has not been preserved.

It must, I think, be included in *Pilumnopeus* of A. Milne-Edwards, a genus which, to judge from the descriptions, can scarcely be distinct from *Eurycarcinus* of the same author. From *Sphærozius*, Stimpson, this species is distinguished by its much broader carapace; from *Actumnus*, Dana, by the same character, and by the brevity of the basal antennal joint.

*Eriphia laevimana*.

*Eriphia laevimana*, Latr. (ined.), Guérin, Icon. Cr. pl. iii. fig. 1; M.-Edwards, Hist. Nat. Cr. i. p. 427 (1834); Dana, Cr. U.S. Explor. Exp. xiii. i. p. 249, pl. xiv. fig. 7 (1852); Hilgendorf, Cr. in V. der Decken's Reise in Ost-Afrika, iii. p. 75 (1869); Monatsb. Ak. Berlin, p. 797 (1878); A. M.-Edwards, Nouv. Arch. Mus. Hist. Nat. ix. p. 255 (1873).

*Eriphia trapeziformis*, Hess, Arch. f. Naturg. p. 135, pl. vi. fig. 4 (1865).

A male and female specimen of this species, presenting all the characteristics of the typical form, are in the collection.

I unite with *E. laevimana* the *Eriphia trapeziformis* of Hess, because there is nothing in the description and figure of the latter form to distinguish it specifically.

*Eriphia laevimana*, var. *Smithii*.

*Eriphia Smithii*, M'Leay, Annulosa, in Smith's Illustr. Zool. S. Africa, p. 60 (1838); Krauss, Südl. Afrik. Crust. p. 36, pl. ii. fig. 3 (1843).

*Eriphia Fordii*, M'Leay, l. c. p. 60 (1838).

*Eriphia laevimana*, var. *Smithii*, Hilgendorf, Monatsb. Akad. Berlin, p. 797 (1878).

New Guinea (an adult male).

The tuberculation of the chelipedes is subject to much variation according to Hilgendorf (l. c.), whom I follow in considering *E. Smithii* merely a variety of *laevimana*, the series in the Museum collection not being large enough to show whether the differences between the two forms are constant.

I may note, however, that in two specimens (young male and adult female) from Natal, which I regard as typical conditions of *E. Smithii*, the surface of the larger chela is strongly granulated between the tubercles, which are rounded and not crowded, and occupy only the upper part of the outer surface; and the tubercles of the smaller hand are crowded and acute, and cover the whole of the outer surface of the hand. In the specimens from New Guinea, also a male from Zanzibar, a female from Dukhun (Deccan?), India, and in a young female received from the Paris Museum under the name of *E. rugosa*, M.-Edwards\*, the surface of the larger hand, between the tubercles (which are very faintly marked or obsolete), is smooth, and the tubercles of the smaller hand are less numerous and acute, and show a tendency to disposition in longitudinal series.

Of this form I have also seen a fine male from Pulo Sambu, Singapore, in a collection made by Surgeon-Major Samuel

\* I do not know that this name has ever been published.

Archer, A.M.D., and which is in process of determination by Mr. A. O. Walker, F.L.S. Were it not for its occurrence also at Zanzibar, I should have had little doubt of the distinctness of this variety from the *Smithii* of Natal.

*Trapezia cymodoce* (Herbst).

A male example from Amboina belongs to this species as I have characterized it (Ann. & Mag. Nat. Hist. ser. 5, ii. p. 408, 1878).

*Neptunus pelagicus* (Linn.).

Celebes, Badjoa (an adult male); Borneo, Bandjermasin (a smaller female).

*Neptunus trituberculatus*, Miers.

An adult male is in the collection, without special indication of locality.

*Neptunus sanguinolentus* (Herbst).

W. Borneo (a female); Bali (another female).

*Scylla serrata* (Forskål).

Bali (a male example); W. Borneo (a young male, showing the rudimental condition of the rostral teeth characteristic of the young of this species).

*Podophthalmus vigil* (Fabr.).

Aroe Islands (an adult male in fine condition).

*Thalamita prymna* (Herbst).

A male is in the collection, without special indication of locality.

*Thalamita Stimpsoni*, A. M.-Edwards.

New Guinea (an adult female). A smaller individual, apparently not specifically distinct, is in the collection, from Amboina, in which the fourth lateral tooth is very nearly as large as the rest. It is very probable that Kossmann is right in uniting many species of this genus that, when fewer materials were available for comparison, were considered distinct.

*Goniosoma annulatum* (Fabr.).

Two females are in the Museum, without definite locality. I am not sure that *G. sexdentatum* is specifically distinct from

this ; at least I have seen specimens, apparently belonging to *G. annulatum*, in which the hand is slightly granulated above.

*Goniosoma anisodon*, De Haan.

A female specimen laden with ova is in the collection, also without definite locality.

[To be continued.]

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XXIV.—*On a supposed Pterobranchiate Polyzoon from Canada.* By the Rev. THOMAS HINCKS, B.A., F.R.S.

SOME years since, I received from my father, the late Professor Hincks, of University College, Toronto, a short notice of a Polyzoon which he had obtained in the neighbourhood of that city, but was unable to identify with any described form. Some of its characters were so remarkable and, at that time, so entirely without parallel, that I could not venture (in the absence of specimens) to publish an account of it or to give any opinion upon it. He had no further opportunity of investigating its history ; and, so far as I know, it has not been noticed since by any other observer.

Later discoveries, however, have supplied a clue to the interpretation of this aberrant type, in some particulars at least ; and reading my father's brief and popular diagnosis by their light, we may find in it the indication of a form which, though unique in some respects, has now its allies and its definite place in our system.

Under these circumstances I think it may be interesting and useful to publish some account of it (however imperfect), accompanied by my father's rough sketch of the polypide : it may stimulate those who have the opportunity to search for it, and possibly lead to its rediscovery.

The description given of it, so far as it goes, may, I have no doubt, be relied upon. Professor Hincks was not, indeed, in any special way a student of the Polyzoa ; but his knowledge of animal forms was extensive and accurate, and he was a practised and careful observer.

In a letter bearing date December 20, 1868, he writes :—  
“ I want your assistance in respect to a freshwater Polyzoon found in this neighbourhood, which I must attempt to describe to you. It was found attached to a sunken boat in the river Humber, which falls into Lake Ontario two or three miles west of Toronto.

"The common substance of the colony, resembling sarcode, is in masses of some extent,  $1\frac{1}{2}$  inch deep, and has the little animals protruded all over it. *The ciliated tentacles, about 100 in number, in four rows on two finger-like extensions, the distinct anal canal, and the nervous ganglion leave no doubt of the creature being a Polyzoon of the order Hippocrepia.* The ova (statoblasts) are also abundant, with their marginal anchor-like hooklets; but it does not seem to me to agree with any of the genera which I can find described; much less can I determine the species. . . . . *The two branches of the lophophore do not form a horseshoe figure, but are more entirely separated, thus* (fig. 1). . . . . I add a faithful though rude sketch of the Polyzoon (fig. 2), seen in one direction; it does not show the flexure of the alimentary canal, but it shows the lophophore well; and if you plant the animal as one of a multitude on a gelatinous or sarcode mass (polyzoarium) common to them all, you will have a right idea of its life."

Fig. 1.



Fig. 2\*.



The remarkable feature of this Canadian Polyzoon is the tentacular corona, the peculiarity of which is insisted on in the description, and clearly shown in the accompanying sketch. The tentacles, instead of being disposed in a horseshoe figure and forming a continuous series, as in the ordinary freshwater (or Phylactolæmatous) species, are borne on two distinct erect lobes, which are separated at the base. They constitute, therefore, *two* series, which are ranged along the edge of the finger-like processes. The structure of the corona, in fact, exactly resembles that which we find in the genus *Rhabdopleura*, Allman, and which is characteristic of the Pterobranchiate group of Polyzoa. In what other points the Canadian species may differ from the typical form of the Phylactolæmata, or how far it may agree with it in general character, we have not at present the means of judging; but we have, I think, sufficient ground for believing that there exists in the fresh waters of Canada a Pterobranchiate polyzoon which is separated from

\* This figure, though not a facsimile of the original drawing, accurately represents its essential points.

*Rhabdopleura* by differences probably ordinal in value, and which in some of its characters and in general appearance resembles the ordinary Phylactolæmata.

It is unnecessary to insist on the interest that must attach to such a form should it exist. I trust that this notice may meet the eye of some one who may have the opportunity of searching the locality from which my father's specimen was obtained, and to whom the point to be solved may appear of sufficient importance to warrant a thorough investigation.

XXV.—*The Sponge-fauna of Norway ; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. SOLLAS, M.A., F.G.S., &c.

[Continued from p. 144.]

[Plates X., XI., XII.]

Order TETRACTINELLIDA, Marshall.

Tribe PACHYTRAGIDA, Carter.

Group *GEODINA*, Carter (Family *Geodiidae*, O. Schmidt).

Genus 1. *GEODIA*, Lmk. Type *G. gibberosa*, Lmk.

(*Pyritis*, Sdt.)

2. *CYDONIUM*, Fleming. Type *C. zetlandicum*, Johnst.

(*Geodia*, auct.)

3. *PACHYMATISMA*, Bwk. Type *P. Johnstoni*, Bwk.

4. *CAMINUS*, Sdt. Type *C. Vulcani*, Sdt.

5. *PLACOSPONGIA*, Gray. Type *P. melobesioides*, Gray.

The sponges belonging to the group *Geodina* have been known to naturalists for nearly two centuries, though for the greater part of this time they were lost in that chaotic assemblage which formed the genus *Alcyonium*. It was in 1815 that Lamarck\* defined, under the name of *Geodia*, the first genus of the *Geodina* group; but so powerful a hold had the imaginary *Alcyonian* character of these sponges upon the minds of the zoologists of those days, that even after the generic distinctness of *Geodia* was perceived it was still retained,

\* Mém. du Mus. d'Hist. Nat. i. p. 333, 1815.

even by Lamarck himself, in close connexion with *Alcyonium*, and was regarded as a member of the same family. Lamarck's description of his genus is as follows :—"Polyparium liberum carnosum tuberiforme intùs cavum et vacuum, in sicco durum; externâ superficie undiquè porosâ. Foramina poris majora, in areâ unicâ orbiculari et laterali acervata." On page 334 (*loc. cit.*) he concludes his observations with the remark, ". . . la forme d'une géode close et la facette orbiculaire, et en crible que l'on observe sur les Géodies, constituent leur caractère générique." A single species, *Geodia gibberosa*, Lamk., is given as the type.

In 1828 Fleming\* took from the *Alcyonia* another Geodine genus, and gave it the name of *Cydonium*. His definition is thus given :—"A coriaceous skin, internally carneous, with numerous straight-ridged spicula perpendicular to the surface; polypi with a central opening, and an orifice at the base of each of the eight pinnated tentacles." His type is given as *Cydonium Mülleri* (*A. cydonium*, Müll. Zool. Dan. t. 81. f. 3, 4, 5, a, and Jameson, Wern. Mem. i. p. 563). In his observations he states that the skin consists of animal matter cementing innumerable siliceous grains, and that the spicules, which are collected in bundles and radiate from the centre, become in many cases trifid or tricuspidate immediately under the skin.

Nothing could be clearer from this description than the fact that Fleming had before him a genus of genuine Geodine sponge. There can be no doubt about this; but if there were it would be immediately dispelled by a reference to the figure given by Bowerbank† of Fleming's original type, which is a typical *Geodia zetlandica*, Johnston.

It is remarkable that Fleming should have attached to this sponge the characters of an Alcyonian polype; nor can it be explained by easily-made references to the vigorous imaginations of the early naturalists; it seems more likely that the explanation may be of the following nature. The spicular characters of *Cydonium* Fleming had observed for himself; the Alcyonian characters he could not have observed, because they did not exist; but he identified his sponge with *Alcyonium cydonium* in Müller's Zool. Dan. (*loc. cit.*), which, from Müller's clear and apparently faithful drawings, is evidently a true *Alcyonium*. Fleming next proceeded to add the characters of Müller's specimen to those of his own, and thus produced the curious hybrid we find in *Cydonium Mülleri*. Such cases of mistaken identification are not, I believe, altogether

\* British Animals, p. 516.

† Bowerbank, 'British Sponges,' iii.



unknown at the present day. Nor was Fleming wholly to blame for this blunder; for his type specimen was handed to him by Prof. Jameson\*, who had previously erroneously identified it with Müller's *Alcyonium cydonium*. Müller further contributed his share to the confusion, as appears from the following remarks by Montagu†:—"Müller has also figured what he considers the Linnæan *Alcyonium cydonium* (Zool. Dan. iii. tab. 81); but this is clearly an *Alcyonium* bearing innumerable polypi; and we cannot, therefore, think it is the same as the *Alcyonium cotoneum* of Pallas, which may be the Linnæan *Cydonium*, and is probably a *Spongia*"‡.

But, apart from this curious mistake of Fleming's, one fact stands out in the clearest manner; and that is, the marked distinction which separates Fleming's genus *Cydonium* from Lamarck's genus *Geodia*. Both were regarded by their authors as allied to *Alcyonium*; but while Lamarck's was characterized by a depressed cribriform area and a hollow cavity within, Fleming's was carneous internally and with a few congregated oscules on the exterior. Had Fleming's genus possessed the same characters as Lamarck's, the name *Cydonium* might have been cancelled; as it is, the two genera are independent of each other, and the names *Geodia* and *Cydonium* must be equally retained. Fleming's specific description is altogether inadequate, and the appellation *Mülleri* has no more value than a MS. name; it must therefore yield to that attached to the first adequate description; and this certainly is *zetlandica*, Johnston.

In 1834 Blainville§ adopted with hesitation Fleming's genus *Cydonium*, though, with his usual inaccuracy, he assigned it to Jameson. He placed it, as its describer's definition necessitated, close to *Alcyonium*. Blainville also adopted Lamarck's genus *Geodia*; but this he placed with the sponges (Amorphozoa), as Deshayes and Milne-Edwards like-

\* Mem. Wern. Soc. i. p. 563, 1811.

† Ibid. ii. p. 117, 1818.

‡ [The clear-sighted Montagu was quite right; the *Alcyonium cotoneum* of Pallas and the *Alcyonium cydonium* of Linné are names given to the Geodine sponge so admirably figured by Donati, on whom Linné conferred the well-deserved epithet "OCULATUS Donati." Of this sponge Donati figures, 1750 (!), the external facies, exhibiting the hollow in which would lie the great cribriform oscule (an admirable section), and the spicula in their proper position and separately. The crust of globates, the dermal porrected spicula, the porrecto- and patento-ternates which support the crust, and the acerates of the body of the sponge are all excellently drawn. The minute stellates the microscope of those days would not reveal; but there cannot be a doubt that Donati's sponge, which is Linné's *Alcyonium cydonium*, is most closely related to *Cydonium zetlandicum*.—REV. A. M. NORMAN.]

§ Man. d'Act. pp. 525, 534.

wise did in a note to the genus in their edition of the *Anim. s. Vert.* of 1836.

In 1842 Johnston\* redescribed Fleming's specimen of *Cydonium Mülleri*, and, not recognizing the distinction between *Cydonium* and *Geodia*, placed it in the latter genus with the specific name *zetlandica*.

In 1862 Bowerbank† reconstructed the genus *Geodia*, taking as the basis for his characterization *Geodia Barretti*, Bwk., which, as it happens, possesses the specially Lamarckian character of numerous oscules congregated in a deeply depressed area, though Bowerbank makes no mention of this fact in his generic definition. Through this omission, and the fact that *G. Barretti*, Bwk., is solid and not hollow within, there is nothing in the character of Bowerbank's *Geodia* to distinguish it from *Cydonium*, if we choose to disregard, as we must, the fictitious Alcyonian characters which Fleming erroneously added to his definition of *Cydonium*.

In the same year (1862) Oscar Schmidt‡ also defined afresh the Lamarckian genus *Geodia*, and, by leaving out the characters which Lamarck expressly stated were typical of his genus, caused it to include the *Cydonium* of Fleming. Schmidt described four new species, all of which appear to be true *Cydonia*. He also described (p. 43 *loc. cit.*) a new genus of *Geodiide* under the name of *Caminus*. It differs from *Cydonium* (*Geodia*, Sdt.) in the absence of trifid spicules, and of a needle-down covering the rind, and also by the presence of a single large osculum.

In 1864 Duchassaing de Fonbressin and Gio. Michelotti§ published a description with admirable illustrations of the type species of Lamarck, *Geodia gibberosa*; they also described and figured an allied species, *Geodia cariboa*, D. & M.

In 1866 Bowerbank||, having examined Fleming's type specimens, enters into a long discussion respecting the conflicting claims of the names *Cydonium* and *Geodia*. I quote his summing up:—"The history of this sponge (*Geodia zetlandica*) presents a singular sequence of errors. In the first place, Müller is distinctly wrong in the designation of his species, which undoubtedly is *Alcyonium* of Ray and Linnæus. Prof. Jameson, perhaps misled by the stellate mantlings on the surface, believed the sponge from 'Fullah and Unst' to be the same as Müller's specimen and an *Alcyonium*. Dr.

\* Hist. of Brit. Sponges, p. 195.

† Phil. Trans. p. 1098.

‡ D. Spongien d. Adriat. Meeres, p. 49.

§ Spongiaires de la Mer Caraïbe, p. 104, pl. xxv. figs. 2, 8.

|| Monograph Brit. Sponges, ii. p. 50.

Fleming, at the time of the publication of his 'British Animals,' appears to believe it to be not an *Alcyonium*, but still identical with Müller's specimen, and accordingly gives it both a new generic and specific name. At last Johnston, seeing that it is not the type of a new genus, sinks both Dr. Fleming's generic and specific names, and, correctly assigning the specimen to *Geodia*, renames it *zetlandica*."

In 1866 \* Oscar Schmidt, in discussing the synonymy of Bowerbank's genera, expressed his doubts as to the position of *Geodia M'Andrewi*, Bwk., and stated that it might perhaps be a *Caminus*. He adopts Bowerbank's genus *Pachymatisma*, and suggests that *Geodia*, Bwk., is equivalent to *Geodia*, Sdt., plus (with a query) *Caminus*, Sdt.

In 1867 Dr. Gray †, for the first time since its institution, asserted the claims of Fleming's genus to an independent existence. Earlier in the year Dr. Gray had described and figured a new and curious Geodine sponge in which the cortex is divided into a number of distinct plates, and which possesses a central axis of globose spicules. This he made the basis of a new genus, *Placospongia*, and, indeed, of a whole new family, the *Placospongiade*. Dr. Gray's arrangement of the Geodine sponges is as follows:—

#### Fam. 1. Geodiadæ.

Genus 1. PACHYMATISMA, Bwk. *P. Johnstoni*, Bwk.

2. GEODIA, Lmk. *G. gibberosa*, Lmk.

3. CYDONIUM, Fleming. *C. Barretti*, Bwk.

4. ERYLUS, Gray. *E. mammillaris*, Sdt.

5. TRIATE, Gray. *T. discophora*, Sdt.

6. CAMINUS, Sdt. *C. Vulcani*, Sdt.

#### Fam. 2. Placospongiadæ.

Genus 1. PLACOSPONGIA, Gray. *P. melobesioides*, Gray.

In 1868 Bowerbank ‡ commented on Dr. Gray's reinstatement of Fleming's genus as follows:—"Dr. Fleming describes his genus as having polypi with a central opening and an orifice at the base of each of the eight pinnated tentacles, showing either that he had greatly mistaken the nature of

\* Zweites Suppl. d. Spong. d. adriat. Meeres, p. 11.

† Proc. Zool. Soc. 1867, pp. 127, 492.

‡ Proc. Zool. Soc. 1868, p. 131.

*G. zetlandica*, Johnst., or that he had described the orange-coloured variety of *A. digitatum*, Johnst. (Brit. Zooph. ed. 2, vol. i. p. 174). *The latter appears the most probable.*" The italics are mine; and it is scarcely conceivable that Bowerbank can have written this after what he said in 1866, and after an examination of Fleming's type specimens, which he then stated were *Geodia zetlandica*. It will be observed also that Bowerbank says nothing here of the presence of the trifid spicules and globates, which Fleming mentions as occurring in his *Cydonium*, and which by themselves are sufficient to prove that Fleming can have had no other than a Geodine sponge before him.

In 1869 Carter\* described a new species of *Cydonium* as *Geodia* (*Cydonium*, Gray) *arabica*; and he added afterwards that his *G. arabica*, being closely allied to *G. zetlandica*, appears under Dr. Gray's third genus, viz. that termed "*Cydonium*."

In 1870 O. Schmidt† gave an account of the characters of the Geodinidæ, added some remarks on the genus *Geodia*, Sdt., and established a new genus, *Pyxitis*. This new genus is characterized by the occurrence in most of its members of a large body-cavity, and in all by the localization of a pore-area for the outflowing water-currents—the very characters seized upon by Lamarck as typical of his *Geodia*! But, worse than this, Lamarck's type *Geodia gibberosa* is appropriated by Schmidt as the type of his genus *Pyxitis*. It is certain that this kind of nomenclature will never be tolerated by impartial naturalists. A genus may be subdivided any number of times that may be necessary; but it is always understood that that subdivision which retains the type species shall also retain the original name‡. If Schmidt thought it necessary to distinguish those Geodine sponges in which "durch Localisirung eines Porenfeldes für die Ausströmung so bestimmt &c.," from others in which such is not the case, he might, with some show of justice, have given a new name to the latter, but certainly not to the former, which belong inalienably to Lamarck's genus *Geodia*. This distinction, made by Schmidt in 1870, existed, however, in our nomenclature as early as the year 1828, the date of Fleming's genus, and was again distinctly enforced by Gray in 1867, three years prior to Schmidt's publication of it. Yet Schmidt, who, when Nardo is in question, is such a champion of priority, calmly ignores the observations of both his predecessors and pro-

\* Ann. & Mag. Nat. Hist. ser. 4, vol. iv. p. 4, pl. i. figs. 9–16.

† Spong. Fauna d. atlantischen Gebietes, p. 68.

‡ See Rule § 4 of the Stricklandian Code.

ceeds, without altering the essential characters of Lamarck's genus, to give it a new name. No wonder that complaints of an overburdened nomenclature are becoming chronic!

In the years 1872-74 numerous descriptions of new species belonging to the genera *Cydonium*, *Geodia*, and *Pachymatisma*, accompanied by beautiful drawings, were published by Bowerbank\*.

In 1874 likewise appeared the 3rd vol. of Bowerbank's 'British Sponges,' containing a fine figure of that typical specimen of *Geodia zetlandica* which had previously been examined and described by Fleming and Johnston.

In 1873 Grube† described and figured a specimen of *Pachymatisma Johnstoni*, Bwk., under the name of *Caminus osculosus*. It came from the coast of St. Malo.

In 1876‡ Carter described, with many interesting observations, two new species of *Geodia*—one with cribriform depressions (*G. nodastrella*), and the other with a single vent (*G. megastrella*).

The table given at the commencement of this paper represents the classification as it at present stands. The genera appear to me to require fresh examination and revision; but this is a subject to which I hope on a future occasion to recur.

### *Geodia Barretti*, Bwk. §

The specimen under description differs only in trifling details from *Geodia Barretti*, and must necessarily be included in that species.

In form it is almost spherical, 1 inch in diameter, free, with a small Halichondroid sponge attached to it, the surface of attachment measuring  $\frac{1}{4}$  inch square. It possesses a single circular oscule (Pl. X. fig. 3)  $\frac{1}{16}$  inch in diameter, situated in the centre of a low dome-shaped elevation, 0.15 inch in diameter, which rises from a shallow annular depression. The surface is smooth except for the protrusion of a few long fusiform acerate spicules at one or two particular spots, and of a large number of minute acerates generally, which render it finely hispid.

The spicules (see figures on Pl. XI.) do not differ in character from those already described by Bowerbank; but it may be as well to call attention to the great length of the shafts of

\* Proc. Zool. Soc. 1872-74.

† Mittheil. ü. St. Malo u. Roscoff &c. p. 132, Taf. 2. figs. 3, 3 a-e.

‡ Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. p. 397, pl. xvi. figs. 45-47.

§ Phil. Trans. 1862, pl. xxxii. fig. 2; Hist. Brit. Sponges, i. 1864, p. 167, pl. xxviii. fig. 254; and Proc. Zool. Soc. 1872, p. 198, pl. xi.

the slender porrecto- and recurvo-ternate spicules (Pl. XI. figs. 8, 9, and 16), as these are not completely represented in Bowerbank's illustrations. In addition to the cylindro-stellates mentioned by Bowerbank there are also present in the mark a number of sharp-rayed forms, of which an instance is represented in Pl. XI. fig. 20. The cylindro-stellates of the mark often attain a much larger size than those of the cortex, which are exceedingly minute.

The arrangement of the spicules has also been excellently described by Bowerbank, so that I need now only call attention to the distribution of the stellates. The cylindro-stellates are confined to the rind and the mark immediately surrounding the crypts, the sharp-pointed forms commence immediately below the crypts, and are found throughout the rest of the mark. They never occur in the rind. This distribution is identical with that existing in *Stelletta Normani*, and probably in most Pachytragus sponges possessing two varieties of stellates.

*The Canal-system.*—The single oscule opens into a cylindrical tube with a rounded termination (Pl. X. fig. 1); it is 0.15 inch long and 0.1 inch wide; its walls are smooth, but rendered finely hispid by the projecting ends of small acerate spicules, which cannot be seen with the naked eye. Ending against the apparently imperforate walls of this tube, two canals are seen in a transverse section of the sponge; they are 0.1 inch wide, and descend from the oscular tube in a curved direction more or less concentric with the outer surface of the sponge. Although only these two tubes are shown in a single transverse section, there can be no doubt that others exist and would be revealed by fresh sections taken in different directions. The interior of these large excurrent tubes or main trunks of the excurrent system (for such they are) has a smooth glistening surface, which is concentrically striated by fine circular ridges and furrows, reminding one in general appearance of the "valvulæ conniventes" of the small intestine, though of course they are of very diminutive size (Pl. X. fig. 2, r). Similar folds, but possibly not quite so regular, exist in Mr. Carter's sponge *Axos spinipoculum*, and have suggested the same comparison to him (Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pl. xxv. figs. 4, 5, p. 287). A number of sharply defined circular openings are seen in the walls of the excurrent trunks, the commencement of secondary canals which proceed from them and branch repeatedly in the substance of the sponge.

Under a low-power magnification and by reflected light the oscular tube exhibits two or three small circular openings,

which place it in free communication with the excurrent trunks. These visible openings, however, are but one or two out of a great number unseen, and which are not seen because they are closed by sphincters; they can readily be made out, however, in sections by transmitted light.

We shall recur to them in describing the histology of the sponge in detail; it is sufficient to state now that the excurrent trunks, which break up into small canals in the interior of the sponge, communicate with the oscular tube by means of sphincters, and thus can be shut off from or put into communication with the exterior as circumstances may determine. The incurrent canals can best be studied in thin sections (Pl. X. fig. 6, and Pl. XII. fig. 34); the pores of the dermis lead into chones, which open each by a sphincter into the subcortical crypts; from the floor of each crypt a cylindrical tube of sharply defined outline (Pl. X. fig. 6, *i*, and Pl. XII. fig. 34) extends downwards for a variable distance into the mark, and, branching below like a bronchus, ends in fine canaliculi. Its walls are more or less finely perforated by openings from which minute canaliculi proceed. Lying parallel with these incurrent tubes and between them are others of a different character; they are generally wider, less regular in form, with more widely perforated walls, and are occasionally traversed by an irregular trabecular network (Pl. X. fig. 6, *e*, and Pl. XII. fig. 34). From the perforations in their walls canals proceed, which, after branching once or twice, and sometimes anastomosing, end in fine canaliculi. The position of these excurrent tubes with respect to the incurrent tubes is inverse; *i. e.* their open extremity is turned towards the centre of the sponge, their more or less closed end towards the rind, while the incurrent tubes lie with the closed end towards the centre and the open end towards and in free communication with the crypts. The floors of the crypts open into narrow short canaliculi like those proceeding from the incurrent canals; and in both cases these fine canaliculi open, somewhat abruptly, into ciliated chambers, the outflow-canals from which constitute the canaliculi of the excurrent tubes. These excurrent tubes, the primary twigs of the branched excurrent system, communicate with larger canals, which run concentrically with the exterior surface of the sponge (Pl. X. fig. 6, *c*). From these concentric canals other canals with trabecular walls proceed and extend deeper into the mark (Pl. X. fig. 6, *e'*), branching till they end in fine canaliculi. These canaliculi end in ciliated chambers, which are connected by shorter canaliculi with other tubes resembling in general character the primary incurrent canals. At first sight the representation of the canal-system

shown in figure 6 gives one the idea that the canals marked *e'* are distributive and not collective in function, in which case the water, which had already passed from the incurrent into the excurrent canals, would be again distributed through a fresh set of ciliated chambers, and thus be used twice over. This does not appear probable. The tubes *e'* have all the characters of excurrent tubes—widely perforated trabecular walls with dichotomous canals opening into them; while the tubes *i'* are equally incurrent in character and give off canaliculi, which enter the ciliated chambers in the abrupt fashion so characteristic of incurrent canaliculi. To complete our representation of the canal-system we must therefore suppose that the incurrent canals *i'* are connected in a round-about way by concealed canals with the subcortical crypts. By this supposition a double using of the incurrent water is avoided. In the centre of the sponge one observes sections of canals cut across in every possible direction; but even here the distinctive characters of the excurrent and incurrent canals, as described above, appear to be maintained.

The general course of the water-circulation of the sponge would appear to be as follows:—The water finds access through the dermal pores or ostia to the chones, whence it finds its way into the subcortical crypts and the incurrent canals; from these it is distributed by multitudinous little canals to the ciliated chambers, the seat of the energy on which the working of the water-circulation depends. From these chambers it passes out by fine canaliculi, which, after uniting together once or twice or oftener, empty themselves into the trabecular excurrent tubes; from these the water flows unobstructed into the large excurrent vessels, which deliver it through sphinctral apertures into the oscular tube, whence it passes freely to the exterior.

### *Histology.*

1. *The Cortex.*—The exterior of the sponge is covered by a thin membranous film, immediately beneath which is a single layer of minute cells (Pl. XII. fig. 26), each containing a minute cylindro-stellate spicule, and having an average diameter of from 0.0002 to 0.0003 inch. The superficial membrane appears to be a mere secretion of the underlying cells, and with them forms the epidermis of the sponge (Pl. XII. fig. 26, *e*).

The epidermis is succeeded by a layer of curious tissue (Pl. XII. fig. 26, *c*), which presents a striking but superficial resemblance to the parenchymatous tissue of plants. It consists of an irregular network of very refringent, faintly bluish,



transparent, narrow trabeculæ, enclosing clear transparent cavities, each of which is provided with a round nucleus and nucleolus lying on the side of one of the trabeculæ (Pl. XII. fig. 24). This is its character in its most completely specialized state; when less specialized its constituent cells can be easily made out (Pl. XII. fig. 25, *a* to *e*). They are 0.001 inch in diameter, of a round, oval, or irregularly polygonal form, and consist of an outer thick hyaline thread-like border or cell-wall, enclosing a large clear vacuole, and a small quantity of finely granular colourless sarcode, in which is imbedded a round nucleus with its nucleolus. They appear to be produced by the metamorphosis of the ordinary protoplasmic cells of the mark, and, by the fusion of their outer borders where these touch one another, give rise to the parenchyma-like tissue just described, to which the name of "vacuolated connective tissue" may be applied. The layer which this tissue forms beneath the epidermis is of variable thickness, on an average from 0.002 to 0.003 inch; it is distinguished by the entire absence of cylindro-stellate or other spicules, the only spicules which occur in it being the small fusiform acerates, which penetrate at one end the subjacent globate layer, and project at the other beyond the surface of the sponge. It may be as well to give this layer of tissue a distinct name; and though the term "dermis" is not altogether free from objection in its application here, it has, at least, the merit of convenience.

The next layer of the cortex, 0.01 inch thick, is that of the globate spicules (Pl. XI. fig. 7, *c*). The characters of these have most of them been already described by other observers. It is a fact, however, worthy of special mention, that some of these spicules contain within a well-marked pit-like hilum a distinct oval nucleus with a spherical nucleolus.

The globates do not lie loosely aggregated together, but are regularly conjoined by short thick fibrillated ligaments. The ligaments pass directly from the side of one globate to the opposed face of its nearest neighbour; and since in the plane of a single transverse section one globate may be seen surrounded by five or six others, so there will also be seen five or six ligaments proceeding from it, like the spokes of a wheel, one for each of its surrounding fellows. As the surrounding globates are also joined to each other by ligaments, so a number of triangles are produced, having the ligaments for their sides and a globate lying on each angle. The centre of the triangle, which is left vacant by the ligaments, is occupied by a cell or cells, which, with their nuclei and nucleoli, exactly resemble one of the vacuolated cells of the dermal

layer. The attachment of the fibres of the ligament is provided by the tubercles of the globate; and when a globate is torn out from the cortex it carries its ligaments with it, as a hair-like coating of radiating fibres.

The fibres are exceeding fine threads, mere lines in thickness, and consist of altered protoplasm, which stains but very slightly with carmine. Small refringent granules occur amongst them; and in places they appear to pass into the fibres of the succeeding cortical layer (Pl. XI. fig. 7, *f*). This, which in describing *Stelletta Normani* (Sollas) we called the muscular layer, is comparatively thin, varying from 0.0015 to 0.0035 inch in thickness. It consists of fibres similar to those of *S. Normani*, arranged in variously oriented fasciæ, in a layer which is closely opposed to the inferior face of the globate layer; intermingled with the fibres are a considerable number of vacuolated connective-tissue cells, which are frequently aggregated together in groups, and sometimes form a distinct stratum on the lower face of the muscular layer, which, most exteriorly, is always covered by an epithelial membrane with associated cylindro-stellates. The trifold heads of the ternate spicules which appear to support the cortex are also imbedded in the muscular layer, the fusiform fibres generally surrounding the spicular rays concentrically. This arrangement is shown on the left-hand side of the endochone in fig. 7 (Pl. XI.).

2. *The Chones*.—The ectochone of the cortical layer has generally the form of an inverted bell, covered by a thin dermal layer above and closed by a muscular sphincter below. From its upper and outer angle canals extend themselves horizontally into the dermis, and, widening out, give rise to a shallow dermal cavity, the roof of which is united to the floor by small columns of connective tissue. The layer of tissue covering the ectochone and that above the dermal cavities are perforated by a number of very short tubes or ostia, which place the cavity of the chone in communication with the external medium. The endochone is a shallow dome-shaped cavity which communicates freely with the subcortical crypt. The surface of the chone and its canals is continuously lined throughout with an epithelial membrane containing numerous cylindro-stellate spicules. The roof of the chone consists of fine fibrous tissue lined below with the stellate-bearing epithelium, which is continued over the sides of the ostia into the layer of epidermis which covers the roof of the chone above (Pl. XII. fig. 33). The fibres of the chonal roof surround the ostia sphinctrally. The ectochone, when it lies in the globate layer, is surrounded by vesicular connective tissue, while the

walls of the endochone consist almost entirely of muscular tissue. From the various states in which the endochone occurs in different cases, sometimes almost entirely obliterated by the closure of its muscular walls, sometimes continuous in one and the same straight line by the widely open state of the intervening sphincter, one may infer that it behaves as a part of the sphinctral muscle: when the upper portion alone of this muscle contracts we have the condition of things represented in Pl. XI. fig. 7; when the whole contracts, that represented in Pl. XII. fig. 30, where the endochone has become constricted to a mere narrow tube; while, should the sphincter remain altogether relaxed, we have the form shown in Pl. XI. fig. 23.

The muscular fibres of this sphincter have here, as in *Stelletta Normani*, a character very different from that of the other fusiform fibres of the cortex; the axial threads are much thicker, the hyaline exterior is reduced in quantity, and the whole muscle has a less transparent and much greyer appearance than in the other case. Moreover the fibres of the lower face of the cortex do not stain deeply with carmine, while those of the sphincters acquire an intense colour with this tinction-reagent. Finally, the latter are so arranged that they can and evidently do contract, and thus are true muscles both by function and structure; while the former occur in such places and arranged in such a manner that it is difficult to understand how, in this sponge at least, they could contract, or what purpose it would serve if they did. Thus, altogether, I begin to doubt how far it is justifiable to extend our ideas as to the nature of the sphinctral fibres to those of the lower cortex, and am much more inclined to regard the latter as forming a kind of fibrous connective tissue, and the former alone as true muscles.

Before leaving the subject of the chones it would be but fair to the memory of Bowerbank to bear our testimony to the striking fidelity which characterizes his representation of the structure of these organs—a fidelity which is the more striking when we consider the comparatively small size which they possess in this species, and recollect the imperfect methods which this much-abused observer had at his disposal.

3. *The Subcortical Crypts*.—Compared with those of *Stelletta Normani*, the crypts beneath the general surface of the sponge are of very trifling dimensions; but beneath the surface which gives attachment to an adhering foreign sponge they become abnormally large, attaining a length four or five times that of the average. This probably is a pathological peculiarity due to the disturbance of the normal water-circula-

tion, produced by the probably commensal parasite. The crypts are lined by an epithelial membrane containing numerous cylindro-stellate spicules. The pillars of the crypts are traversed by the long-shafted spicules, and consist partly of mark-substance, and partly of vacuolated connective-tissue cells, which sometimes form a distinct layer beneath the epithelium (Pl. XII. fig. 27). Sometimes the mark-cells of the pillars are elongated into spindle-shaped fibres, which do not generally differ, except in shape, from ordinary mark-cells, but sometimes become hyaline and vacuolated (Pl. XI. fig. 15, *g* and *v*).

4. *The Incurrent Tubes*.—The tubes are simple excavations in the mark, lined by epithelium, which consists of a single layer of flattened cells, furnished with a round nucleus and nucleolus, but with indistinct or invisible cell-borders.

5. *The Excurrent Tubes*.—The smaller canals (Pl. XII. fig. 32) of the excurrent system do not differ from the corresponding incurrent tubes in structure; but the larger tubes have walls of a much more complex character. The large vessels, for instance, which open into the oscular tube are first lined by an epithelial membrane containing fine fibrils and round or oval nuclei with their nucleoli; beneath this follows a colourless transparent layer, which scarcely stains with carmine, and attains a thickness of 0·0007 inch. It consists of fine fibres (Pl. XI. fig. 15, *f*) of considerable length, with a swollen middle part, in which a central round granule or small nucleus may sometimes be discerned, and of vacuolated connective-tissue cells, which, when they lie immediately under the epithelium, sometimes contain a sharp-rayed stellate spicule. The rugæ of these vessels consist of an extension of the fine fibrillar layer covered by the epithelium. Globate and small acerate spicules occur in the walls of these vessels.

6. *The Oscule and Ocular Tube*.—The wall of the oscular tube below the cortex (Pl. X. fig. 2) is 0·02 inch thick, and consists for the most part of fibrous tissue, which does not stain with carmine, and is traversed by a number of small acerate spicules, which project from it erectly, and thus produce the hispid appearance of its surface previously mentioned. Vacuolated connective-tissue cells occur intermingled with fibres on both the inner and outer face of the wall; and the outermost layer consists of epithelial membrane. On the inside of the wall the epithelium is associated with minute cylindro-stellates like those of the epidermis, on the outside with larger sharp-rayed stellates like those of the mark. In places the fibrous tissue of the wall passes into true muscular

fibres, which form the sphincters already mentioned. These sphincters are well exposed by a tangential section of the oscular tube-wall; in such a section (Pl. X. fig. 4) the wall is seen to be divided into a number of polygonal areas, the boundaries of which are marked by a few globate and acerate spicules, while the greater part of the area of the polygon is occupied by one of the sphinctral muscles, which, in carmine-stained sections, have a deep red colour, strongly contrasting with the uncoloured tissue of the polygonal boundary.

In the cortex (Pl. X. fig. 5) the oscular tube is lined by epithelium bearing stellates, and overlying first a finely fibrous layer, and then a thin stratum of vacuolated connective tissue, which covers the globate-layer, here very much increased in thickness, as also is the underlying cortical fibrous layer. The roof of the oscular tube consists of a thin fibrous layer, without globates, but traversed by acerate spicules and covered by a layer of cylindro-stellates above and below.

7. *The Ciliated Chambers*.—The spherical outline of these chambers, which measure 0.001 inch in diameter, bears upon its inner surface a number of small, round, highly refringent nuclei with minute nucleoli, set at regular intervals from each other; but the outlines of complete cells cannot be made out, any more than can the cilia. A sharply marked circular aperture furnishes an abrupt passage from the interior of the chamber to the incurrent canal, on which the chambers are set, while the opening into the excurrent canal, on the other hand, appears to be much more gradual and prolonged (Pl. X. fig. 6 A, and Pl. XII. fig. 36).

8. *The Mark*.—The substance of the mark, independent of the tissues which enter into the composition of the canal-system, consists of finely granular sarcode, with large oval nuclei, containing nucleoli (Pl. XII. fig. 31) scattered throughout it. It stains with carmine, but not so intensely as its imbedded nuclei. The nuclei (Pl. XII. fig. 29), which are sometimes round as well as oval, have a well-marked double contour, 0.0002 to 0.0003 inch in diameter, and contain a clear unstained space, within which is the deeply stained round nucleolus 0.0001 inch in diameter. The mark-tissue might be taken for a "syncytium," were it not that in some cases distinct cells can be made out in it, having nuclei of precisely the same characters as those just described, and consisting of granular sarcode just like the ground-mass of the mark. These cells (Pl. XII. figs. 28, 32), 0.0008 inch in diameter, have a very faint external contour; and one can readily understand how, in a sponge not specially prepared for histological examination, the borders of such cells would

become altogether undistinguishable in the majority of cases, and so, by a deceitful appearance of confluence, give rise to the notion of a syncytium. Connective tissue like that of the medusoid disk is not discoverable in this sponge; in *Thenaea Wallichii*, Wright, however, the greater mass of the mark consists of it.

9. *The Spicules*.—The long-shafted spicules are enveloped in a sheath which somewhat resembles the epithelial membrane, and are accompanied by longitudinally arranged fibres like those of the cortex; they are also frequently closely surrounded by concentric fibres of a very simple appearance, consisting merely of thin flat fusiform hyaline strips with a small round central granule or nucleus.

The globates of the cortex are all full-grown forms; but those dispersed through the mark are to be met with in all stages of development. In their earliest state they consist of minute trichites, radiately arranged to form a sphere, the centre of which is either empty or occupied by some transparent substance like that of the axial thread of a long-shafted spicule. The outer ends of the trichites penetrate a thick double-contoured cell-wall, which is at first transparent and almost colourless (Pl. XII. fig. 37). On one side of this cell-wall is imbedded an oval nucleus, which strikingly resembles the nuclei of the mark-cells. With growth a deposit of silica is formed about the inner ends of the trichites, cementing them together into a transparent siliceous globule; the outer diverging ends remain unenveloped, and are easily detached from the central sphere. A hilum is for some time absent; but presently the growth of the trichites beneath the nucleus becomes slow compared with that outside it (Pl. XI. fig. 18), and as a result a conical cavity is left under the nucleus and forms the hilum of the adult spicule. The nucleus, when viewed face on, appears to rest, like a biconvex lens, over the upper end of the hilum; but a lateral view presents it as completely filling the cavity of the hilum. The cell-wall enlarges with the growth of the globate, and very early acquires a very granular appearance and a deep grey colour; it then stains deeply with carmine. Probably the preceding statement should in one point be reversed, and we should say that the trichites increase in length with the growth of the cell-wall. Finally the trichites become thicker and acquire rounded conical ends, which at length assume the characteristic adult form.

It is singular that no immature forms are met with in the cortex; and this leads one to infer that the fully-grown globate travels in some manner unknown from the mark to the lower

face of the cortex, where its dense sarcodic coating becomes metamorphosed into fibrous ligaments; only in some such manner as this can the additional globates needed for the increased area of the cortex, consequent on the growth of the sponge, be explained. It is, moreover, suggested by the fact that in embryonic *Geodia* the globates are at first absent in the cortex, and make their earliest appearance within the mark.

The stellate spicules, as we have already stated, are produced within the interior of cells; they may frequently be observed within a cell resembling one of the vacuolated connective cells, with transparent sarcode filling up the angles between their rays (Pl. XI. fig. 22).

*Classification.*—It may be thought singular to refer to *Geodia* a sponge which apparently possesses neither the cribriform oscular area nor the large body-cavity which characterize that genus. But it is to be recollected that we have been describing a young specimen, the structure of which is in all respects so similar to that of *Geodia Barretti* that no one could refuse to refer it to that species, and, next, that, according to Bowerbank's descriptions, *Geodia Barretti* clearly belongs to the genus to which we have assigned it; for, setting aside the absence of a large body-cavity, which is not really essential to *Geodia*, we have the genuine *Geodia* character displayed by Bowerbank's specimens in the possession of a large cribriform oscular area. In our sponge this area is represented by the walls of the oscular tube, which may, with growth, become a mere shallow depression, or may enlarge, as Bowerbank's descriptions show, into a cavity as much as two inches in depth.

*Locality.* Kors Fiord, Station No. 23. Depth 180 fathoms.

#### EXPLANATION OF THE PLATES.

##### PLATE X.

- Fig. 1.* The cut face of a young specimen of *Geodia Barretti* divided longitudinally through the oscular tube (nat. size).  
*Fig. 2.* Transverse section through the wall of the oscular tube below the cortex: *s*, sphincters; *e*, excurrent vessel, cut across obliquely; *r*, rugæ of its walls ( $\times 11$ ).  
*Fig. 3.* Upper surface of the sponge, showing the single oscule at the summit (nat. size).  
*Fig. 4.* Tangential section through the wall of the oscular tube, showing sphincters, *s*, in the middle of polygonal areas ( $\times 11$ ).  
*Fig. 5.* Transverse section, showing one side of the oscular tube in the cortex, the greatly thickened globate-layer, and the thin dermal roof ( $\times 11$ ).  
*Fig. 6.* Transverse section through the mark and cortex, showing the arrangement of the water-canals: *ch*, *ch*, chones; *cr*, crypts;

*i*, incurrent tube; *e*, excurrent tube; *c*, concentric canals; *e'*, a deeper-seated excurrent tube; *i'*, a deeper-seated incurrent tube ( $\times 24$ ).

*Fig. 6A.* Ciliated chambers in longitudinal optical section and from a view face on ( $\times 435$ ).

#### PLATE XI.

*Fig. 7.* Section through the cortex, showing the structure of the chone and the ligamentous connexions of the globates (*c*): *f*, the fibrous layer ( $\times 104$ ).

*Figs. 8, 9.* Porrecto- and recurvo-ternate spicules with long slender shafts.

*Fig. 10.* Fusiform acerate spicule.

*Fig. 11.* Bifurcated ternate spicule.

*Fig. 12.* Globate spicule.

*Fig. 13.* Small acerate from the cortex.

*Fig. 14.* Small ternate from the upper angle of one of the crypts. *Figs. 8-14* all magnified 21 diameters.

*Fig. 15.* Fusiform fibres of different kinds: *g*, granular mark-cell from pillar of a crypt; *v*, vacuolated cell from same place; *s*, axial thread of a muscle-fibre from a sphincter; *f*, fibres from the wall of one of the large excurrent tubes ( $\times 435$ ).

*Fig. 16.* Porrecto-ternate spicule ( $\times 21$ ).

*Fig. 17.* Cylindro-stellate from the mark ( $\times 315$ ).

*Fig. 18.* Globate spicule, showing the nucleus at one side ( $\times 435$ ).

*Fig. 19.* Young globate as seen in Canada balsam ( $\times 435$ ).

*Fig. 20.* Stellate with sharp-pointed rays, from the mark ( $\times 315$ ).

*Fig. 21.* Cylindro-stellate from the epidermis ( $\times 435$ ).

*Fig. 22.* Stellate-cell with its contained spicule ( $\times 435$ ).

*Fig. 23.* Section of a chone with widely opened sphincter ( $\times 30$ ).

#### PLATE XII.

*Fig. 24.* Vacuolate connective tissue from the dermis ( $\times 435$ ).

*Fig. 25.* An unaltered mark-cell occurring associated with vacuolated connective-tissue cells: *a-e*, various stages in the development of these cells ( $\times 435$ ).

*Fig. 26.* Section across the outer part of the cortex, showing—*e*, epidermis and *c*, dermis, resting upon the globate-layer.

*Fig. 27.* Wall of a crypt, taken from one of its upper corners, showing epithelium overlying a layer of vacuolate connective-tissue cells ( $\times 217$ ).

*Fig. 28.* A typical mark-cell, showing nucleus and nucleolus imbedded in fine granular sarcode ( $\times 435$ ).

*Fig. 29.* Nuclei which occur dispersed through the granular substance of the mark ( $\times 435$ ).

*Fig. 30.* Section of a chone, showing obliteration of endochone through the contraction of its muscular walls ( $\times 26$ ).

*Fig. 31.* A trabecula of one of the excurrent canals, to show the general character of its constituent mark-substance ( $\times 435$ ).

*Fig. 32.* A transverse section through a small canal in the mark; the surrounding mark-cells are distinguished by faintly defined outlines ( $\times 435$ ).

*Fig. 33.* A transverse section through a dermal ostium, showing stellate-bearing external layer and central fibrous layer ( $\times 217$ ).

*Fig. 34.* Section through cortex and mark, in which the incurrent canals



are more characteristically represented than in Pl. X. fig. 6 ( $\times 30$ ).

*Fig. 35.* One of the fusiform fibres that are sometimes found lying longitudinally upon the side of a small acerate spicule ( $\times 435$ ).

*Fig. 36.* Section along an incurrent canal lying in the middle of the mark, showing ciliated chambers and the small outflow-tubes leading towards an excurrent canal ( $\times 140$ ).

*Fig. 37.* A very early form of globate spicule, from a preparation in glycerine ( $\times 435$ ).

[To be continued.]

## PROCEEDINGS OF LEARNED SOCIETIES.

### GEOLOGICAL SOCIETY.

January 21, 1880.—Henry Clifton Sorby, Esq., LL.D., F.R.S.,  
President, in the Chair.

The following communications were read:—

1. “On the Genus *Pleuracanthus*, Agass., including the Genera *Orthacanthus*, Agass. & Goldf., *Diplodus*, Agass., and *Xenacanthus*, Beyr.” By J. W. Davis, Esq., F.G.S.

The author commenced with an historical account of the supposed genera of fishes founded on remains occurring in Carboniferous and Permian strata, mentioned in the title of his paper. The teeth described by Agassiz under the name of *Diplodus* have been already shown by Sir Philip Egerton to be associated with spines of the *Pleuracanthus* type; and this identification was accepted by the author, who also showed that *Xenacanthus*, Beyrich, is identical with *Pleuracanthus*, and that, on the ground of priority, which there is no reason for disregarding, the latter name ought to be retained. With regard to *Orthacanthus*, he indicated that in the type described by Agassiz the two rows of denticles are placed close together along the posterior face of the spine, while in his *Pleuracanthus* the denticles are situated as far as possible apart on the sides of the spine. In the new Carboniferous species described in the present paper, and in those described and figured by the officers of the United-States Survey, the denticles occupy almost every intermediate position between these two extremes; and hence the author was inclined to unite *Orthacanthus* with *Pleuracanthus*. *Compsacanthus*, Newb., is also probably nearly related to *Pleuracanthus*. The author described in some detail the characters of the genus *Pleuracanthus*, and discussed its scientific position, with regard to which he inclined to the adoption of Dr. Rudolph Kner's opinion that the *Pleuracanthus* constitute a type of fish intermediate between the Elasmobranch and Teleostean fishes, but more nearly approaching the latter, probably through the Siluroids.

Ten species of the genus *Pleuracanthus*, modified as above, were described by the author from the Coal-measures, principally of Yorkshire. Eight of these were described as new.

2. "On Mammalian Remains and Tree-trunks in Quaternary Sands at Reading." By E. B. Poulton, Esq., F.G.S.

The author described in detail a pit opened on the south slope of the Thames valley on the Redland Estate at Reading, about 36 feet above the river-level. The north face shows gravels and alluvia containing chalk-flints and fossils, fragments of Oolitic limestone and fossils, and scattered materials of the high-level gravel, overlying reconstructed beds (sands and clays) composed chiefly of the debris of the Woolwich and Reading beds, and in part of the basement bed of the London Clay. The author noticed especially the traces of fluvial action displayed in these reconstructed Tertiary materials, and the fossil remains found in the sands and gravels, which included traces of *Elephas primigenius*, *Bos primigenius*, *Equus fossilis*, and ? *Rhinoceros tichorhinus*, besides numerous portions of trunks of trees, in some parts of which traces of coniferous structure had been recognized. The characters presented by this pit were of interest, as adding another to the scattered evidences of the existence in postglacial time in the valley of the Thames of a larger river occupying that valley, and flowing at from 20 to 30 feet higher than the present river.

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#### MISCELLANEOUS.

*The Cave-Bear of California.* By E. D. COPE.

IN exploring a cavern in the Carboniferous Limestone of Shasta County, Cal., James D. Richardson discovered the skull of a bear beneath several inches of cave-earth and stalagmite. The specimen is in a good state of preservation, and demonstrates that the cave-bear of that region was a species distinct alike from the cave-bear of the East (*Ursus pristinus*) and from any of the existing species. In dimensions the skull equals that of the grizzly bear, but it is very differently proportioned. The muzzle is much shorter and is wide, and descends obliquely downward from the very convex frontal region. It wants the large postorbital processes of the grizzly, but has the tuberosities of the polar bear (*U. maritimus*), which it also resembles in the convexity of the front. Sagittal crest well developed. Three (one median and posterior) incisive foramina; three external infraorbital foramina. The teeth are large; and the series presents the peculiarity of being without diastema. The crowns of the premolars are not preserved; but if there were not three premolars, the second tooth has two well-developed roots. First true molar with but two external and one internal tubercle. The absence of diastema renders it necessary to separate

this bear from the true *Ursi*; and I propose to regard it, provisionally, as a species of *Arctotherium*, Gerv. The canine teeth are large, and compressed at the base. Length of cranium, along base from below apex of union to premaxillary border, 0·387 metre, length to posterior nares ·202, elevation of forehead vertically above the posterior extremity of the last molar ·141, width between inner border of posterior molars ·076. The species may be called *Arctotherium simum*.—*American Naturalist*, December 1879.

*On the Systematic Position of some little-known Asiatic Mantodea, with Descriptions of two new Species belonging to the Genus Hestias.* (Abstract.) By J. WOOD-MASON.

#### Genus HESTIAS, Saussure.

The genus *Hestias*, proposed in 1871 by De Saussure for the reception of a remarkable insect from Sylhet, is referred to the subfamily Harpagidæ, wherein it must take its place next after, or in the immediate neighbourhood of, *Acromantis* and its allies, from which it is readily distinguishable by the form of the prothorax, by the structure and by the peculiar style of colouring of the insides of the fore legs, &c. The author recognizes five species (of which two are now for the first time described), viz. :—

##### 1. *Hestias Brunneriana*, Saussure.

*Hestias Brunneriana*, Saussure, Mél. Orthopt. i. 1871, 3<sup>me</sup> fasc. p. 454, ♀; Wood-Mason, Proc. As. Soc. Beng. August 1876, ♂ ♀.

*Hab.* Sylhet and Calcutta in Northern India, and Mysore in Southern India.

##### 2. *Hestias Rogenhoferi*.

*Pachymantis Rogenhoferi*, Saussure, Mél. Orthopt. ii. 1872, p. 77, pl. ix. fig. 27, ♀.

*Hab.* Moluccas?

##### 3. *Hestias pictipes*, n. sp.

*Male and Female.* Head with a minute horn shaped like that of *H. Brunneriana* ♂. Organs of flight of female not reaching, of male extending beyond, extremity of abdomen. Tegmina of female with the marginal field opaque light yellowish green, the rest delicately hyaline; wings with marginal field subopaque orange-yellow, the venation of the rest of the organ of the same colour narrowly lined with hyaline, and the meshes pale smoky. Fore coxæ red-violet, especially internally, femora inside on the lower half jet-black, with three distinct white spots in a longitudinal row, and with a narrow black stripe extending from the base along fully three fourths of the length of the margin of the foliaceous expansion, the rest of the surface being rich red-violet.

Length of female about 19 millims., of male 17 millims.

The specimen of the male is somewhat bleached from long residence in spirit.

*Hab.* Female, Marble Rocks, near Jabalpur in the Central Provinces of India; male, precise locality unknown.

#### 4. *Hestias inermis*, n. sp.

*Female.* Head without a vestige of a horn, with the postocular tubercles by correlation reduced to low, smooth, and rounded elevations, behind the ocelli longitudinally deeply 4-sulcate. Organs of flight not reaching extremity of body; tegmina with the light opaque umber-brown marginal field pubescent, and with the posterior field rich dark umber-brown, mottled in places with lighter and with hyaline, and crossed beyond the middle by a band half hyaline and half opaque cream-coloured; wings opaque lemon-yellow, very broadly margined with dark brown, with the transverse veinlets lined with hyaline.

Fore coxæ jet-black inside; femora jet-black at base, whence this colour is continued for some distance as a marginal band onto the foliaceous expansion.

Length about 34 millims.

*Hab.* Nāga Hills (*Captain J. Butler*). Very nearly allied to the following.

#### 5. *Hestias phyllopus*.

*Mantis (Oxyphilus) phyllopus*, De Haan, Bijdr. &c. p. 84, pl. xvi. fig. 7, ♂.

The fore femora of male and female have two black stripes in the lower half (primitive femur).

The author has seen a specimen of the female either at Oxford or in the British Museum.

*Hab.* Java.

#### Genus OXYPILOUS, Serville.

The author considers that this genus should be transferred from the Mantidæ to the Harpagidæ, and therein placed between the genera *Hestias* and *Sigerpes*. *Ceratomantis Saussurii*, W.-M., and *Mantis (Oxyphilus) bicingulata*, De Haan, are shown to be closely allied Asiatic species of it, having the same relation to one another, as regards degree of development of the cephalic horn, as have *Hestias Brunneriana* and *Hestias pictipes*. *Oxyphilus* has in common with *Sigerpes* the two posterior ocelli placed at the bases of spines. The author has only been able to study immature specimens of one African species; and if the perfect winged insects of these should hereafter be found to differ sufficiently from those of the Asiatic species to warrant their separation from them generically, the latter must take the name of *Pachymantis* proposed for the reception of De Haan's *Mantis bicingulata* by De Saussure.—*Proc. As. Soc. Beng.* November 1879.

*Description of Sigerpes occidentalis, the Type of a new Genus of Mantodea from West Africa.* By J. WOOD-MASON.

In this short paper a new species of *Mantodea* closely related to the East-African *Sibylla tridens*, Saussure, is described and made the type of a new genus, *Sigerpes*, which must be placed in the sub-family Harpagidæ next to the genera *Oxyphilus* and *Hestias*.

The cephalic horn, as was suspected by the author (P. A. S. B. 1876), turns out to be rudimentary in the males.

The new species, described from a fine dried female specimen in the British Museum from the neighbourhood of Sierra Leone, differs from *Sigerpes* (olim *Sibylla*) *tridens* ♀ in having the cephalic horn somewhat longer and without lateral lobes and teeth, the base of the wings greenish yellow, the fore tibiæ more numerously toothed, the fore femora on the inside red tipped with black, and the extremities of the organs of flight not so obviously truncate.—*Proc. As. Soc. Beng.* November 1879.

*The Cæciliæ.* By Prof. W. PETERS.

Professor Peters has published an important paper on this curious group of Amphibians, in which, after discussing certain critical points, he gives a new division of the known forms into genera, and describes several new species. He finds that his *Gymnopsis multiplicata* (Monatsber. Berl. Akad. 1874) is generically identical with Duméril's *Rhinatrema unicolor*, and that the characters given by the latter author for his genus *Rhinatrema* are erroneous as applied to this species; while the *Cæcilia bivittata* of Cuvier, which was referred by Duméril to the genus *Rhinatrema*, is founded upon immature examples of the Linnean *Cæcilia glutinosa*. Accordingly he sinks the genus *Rhinatrema* altogether, and retains his own name *Gymnopsis* for the genus including his and Duméril's species.

For the division of the Cæciliæ into genera he considers that the position of the tentacular pore alone leads to very unsatisfactory and unnatural results, as, independent of the structure of the skull and viscera, the structure or absence of the dermal scales, the dentition, especially of the lower jaw, and the differences in the form of the tentacle, seem to him to be of much greater importance. The tentacle occurs under three different forms, namely:—dagger-shaped (*cultratum*), which occurs in *Ichthyophis* (*Epicrion*), lies freely in the sheath and can be pushed out like the point of a trocar; valve-like (*valvatum*), placed at the orifice of the sheath and united to its hinder margin, so that it moves round upon this fixed basal part like a flap upon its hinge, although when protruded it appears somewhat spindle-shaped, as in *Cæcilia tentaculata*; and globular (*globosum*), which occurs in *Gymnopsis*, and in which the thin basal part is situated in the bottom of the sheath. An intermediate form occurs in *Cæcilia* (*Herpele*) *squalostoma*; it appears globular externally, but is attached by its extremity to the wall of

the sheath, like the second form, but at a greater distance from the orifice.

With regard to the habits of the species, it appears that *Chthonerpeton indistinctum* and *Hypographis rostratus* have been found living in society at considerable depths in the earth; whilst other species were observed in the East Indies by Colonel Beddome under stones, and *Typhlonectes compressicaudus* and *natans* have been found swimming in fresh water. The branchiferous young of *Ichthyophis glutinosus* has also been taken in the water.

Prof. Peters gives the following Table of the genera:—

- I. LEPIDOCÆCILIÆ.—Skin with tile-like scales, at least on the margins of the folds; mandibular teeth in two rows.
  - A. Extremity of the body pointed; tentacle cultrate.
    - a. Body depressed; body-rings forming an angle in the middle of the belly; tentacular pit near the buccal margin, between eye and nostril ..... 1. *Ichthyophis*.
    - b. Body cylindrical; tentacular pit under the nostril ..... 2. *Urcotyphlus*, g. n.
  - B. Extremity of the body rounded off.
    - a. Tentacular pit horseshoe-shaped; tentacle valvate.
      - \* Tentacle under the nostril ..... 3. *Cæcilia*.
      - † Tentacle behind and under the nostril . 4. *Hypogeophis*, g. n.
    - b. Tentacular pit circular; tentacle globose.
      - \* Eyes visible, in an orbit ..... 5. *Dermophis*, g. n.
      - † Eyes invisible, under the cranial bones.
        - a. Tentacular pit nearer the angle of the mouth than the nostril ..... 6. *Gymnopsis*.
        - β. Tentacular pit nearer the nostril than the angle of the mouth ..... 7. *Herpele*, g. n.
- II. GYMNOCÆCILIÆ.—Skin naked, without tile-like scales; tentacle valvate; tentacular pit horseshoe-shaped.
  - A. Extremity of the body rounded off.
    - a. Mandibular teeth biserial; tentacular pit midway between nostril and eye ..... 8. *Chthonerpeton*, g. n.
    - b. Mandibular teeth uniserial; tentacular pit much nearer the eye than the nostril ..... 9. *Siphonops*.
  - B. Extremity of the body compressed; mandibular teeth biserial; tentacular pit close behind the nostril ..... 10. *Typhlonectes*, g. n.

The genus *Ichthyophis*, Fitzinger (= *Epicrion*, Wagler), includes three eastern species—namely, *I. glutinosus*, Linn., *I. monochrous*, Bleek., and *I. Beddomei*, sp. n. Beddome's *Epicrion carnosum*, *Gegenes carnosus*, Günth., is regarded by Prof. Peters as founded upon very young, immature animals, which, from their cylindrical form and the position of the nostrils, seem to approach *Cæcilia* rather than *Ichthyophis*. As the generic name *Gegenes* has long been pre-

occupied, the author suggests *Gegeneophis* for the genus in the event of its proving to be well founded. *Uræotyphlus* has the tentacular pit circular and the base of the cultrate tentacle at the bottom of the tentacular tube. It includes two East-Indian species—*Cæcilia oxyura*, Dum. & Bibr., and *C. malabarica*, Beddome. The genus *Cæcilia*, as restricted, includes seven American species—namely, *C. tentaculata*, Linn., *isthmica*, Cope, *gracilis*, Shaw, *pachynema*, Günth., *ochrocephala*, Cope, *polyzona*, Fisch. (sp. n.), and *Güntheri*, sp. n. (= *C. rostrata*, Günth. non Cuv.). *Hypogeophis* has the eye visible; the species referred to it are *Cæcilia rostrata*, Cuv., from the Seychelles, and *C. Seraphini*, Dum., from Gaboon and the Camarouns. *Dermophis* includes scaled species, which have been referred by previous authors to Wagler's genus *Siphonops*, founded upon the scaleless *Cæcilia annulata*, Mikan. Prof. Peters refers to *Dermophis* the American species *Siphonops mexicanus*, Dum. & Bibr., *S. brasiliensis*, Lütken, *S. proximus*, Cope, and *S. sinus*, Cope, and the West-African *S. brevirostris*, Pet., and *S. thomensis*, Bocage. *Gymnopsis* closely approaches *Siphonops* in the structure of the skull. To this genus three American species are referred—namely, *G. multiplicata*, Pet., *Rhinatrema unicolor*, Dum., and *Siphonops oligozona*, Cope. *Herpele*, which approaches *Cæcilia* in cranial structure, includes only one species, the West-African *Cæcilia squalostoma*, Stutchbury. In *Chthonerpeton* the tentacular pit is placed midway between eye and nostril, but considerably below the line joining those organs; the only known species is *Siphonops indistinctus*, Reinh. & Lütk., from South America. The sole representative of the restricted genus *Siphonops* is Wagler's type species *C. annulata*, Mikan, from Brazil, Guiana, and Peru. Lastly, in *Typhlonectes* the eyes are distinct, and the anal aperture surrounded by a sort of sucking-disk. The species are all from South America—namely, *Cæcilia compressicauda*, Dum. & Bibr., *C. dorsalis*, Pet., *C. natans*, Fisch., and ? *Siphonops syntremus*, Cope. The foetal form has vesicular branchiæ. Prof. Peters's paper is illustrated with a plate elucidating the characters of the genera.—*Monatsb. Akad. Wiss. Berl.*, November 1879, p. 924.

*Histology, Development, and Origin of the Testis and Ovary in Campanularia angulata (Hincks).* By M. J. FRAIPONT.

The histological study of the three layers, ectoderm, intermediate lamella, and entoderm, of the body in Hydroids, leads to some new and important facts, of which a summary is here given.

The small nematocysts of the ectoderm of the tentacles are surrounded by a slight protoplasmic layer, often nucleolated and individualized, to which a palpocil corresponds. This relation is important from the physiological point of view, and that of the mode of action of the urticant organs.

The endoderm of the stolons in the vicinity of the pedicles of female gonangia (*Campanularia angulata*), and especially in the branches (*C. flexuosa*), contains larger cells, having, on the one hand,

the characters of egg-cells, and passing, on the other, into the endodermic cells. Our master, E. van Beneden, has long since made analogous observations (in *Campanularia dichotoma*), which are still unpublished.

The free extremity of the appendicular organ terminated in a hook is characterized by the development of the ectoderm, by the accumulation in that tissue of corpuscles of special structure, and by the considerable attenuation of the perisarc. These data may perhaps serve to settle the nature of this organ.

In the body and tentacles the intermediate lamella, which elsewhere is amorphous, presents fasciculated fibrils, which insert themselves at definite points, and which I believe to be muscular.

A *gonangium* is formed by a gonotheca, a central system of canals, and some gonophores. The axial canal or blastostyle spreads out into a hammer-head at the upper extremity of the *gonangium*, and furnishes laterally those cæca at the level of which the gonophores are formed. In *C. angulata* and *C. flexuosa* the latter do not become either Medusæ or semi-Medusæ, as in the other *Campanulariæ*; they remain in the condition of diverticula of the wall of the body, and certain of their cellular elements become ovary or testis.

The spermatozooids seem to be formed by a small nucleus, or fragment of a small nucleus, surrounded by a little of the protoplasm of the mother cell, of which the rest serves to form the tail.

The female gonophore contains only one ovum, the germinal vesicle of which, when not fecundated, is analogous to that described by W. Flemming, E. van Beneden, Kleinenberg, O. Hertwig, and Bergh in various animals. It contains a small clear corpuscle of irregular form (Schrön's corpuscle), from which start from three to six filaments which appear to terminate at the inner surface of the germinal spot; carmine colours it strongly. Segmentation by transverse furrows of unilateral direction produces a ciliated *planula* showing a cellular ectoderm and an endoderm.

Four opinions are current as to the origin of the sexual organs: Huxley, Keferstein and Ehlers, Claus, Kleinenberg, Schulze, O. and R. Hertwig think that the sexual organs originate from the ectoderm. On the other hand, Kölliker, Hæckel, Allman, Claus, and Korotneff maintain their endodermic origin. E. van Beneden supports a third opinion, namely the ectodermic origin of the spermatozooids and the endodermic origin of the ova. Van Koch and Bergh confirmed Van Beneden's views. Lastly, Ciamician has maintained the ectodermic origin of the ova and the endodermic origin of the spermatozooids in *Eudendrium ramosum*.

In *Campanularia angulata* and *C. flexuosa* the whole development of the sexual organs may be traced by studying a *gonangium* from its base of insertion to its apex.

In the pedicle of the male gonangium, the cœnosarc is constituted as in the stolons and the branches; but at one or two points the ectoderm is more thickened and its cells better defined. Higher up, at a certain point, the cœnosarc is inflated into a small tubercle, into the interior of which penetrates a cæcal diverticulum of the



central cavity, bounded by a few endodermic cells. Beyond the latter we see the intermediate lamella, then some well individualized ectodermic cells, larger than the others (these are the *mother cells of the testis*); and finally the whole is covered by the ordinary ectodermic cells. In the cavity of the gonangium, at its base, are young gonophores, in which we find, from within outwards, a diverticulum of the cavity of the blastostyle, epithelial endodermic cells, the intermediate lamella, a small cellular mass of a horseshoe shape, originating from a few differentiated ectodermic cells, and, lastly, a layer of ectodermic cells. The little mass is the young testicular tissue. The different gonophores have the same constitution, with the exception of the development of the tissue, which gradually acquires a larger and larger volume. In the uppermost gonophores all the elements which surround the mature testis are in process of atrophy. The conclusion is that the spermatozooids originate from the ectoderm.

In the pedicle of a female gonangium we find at the base one or two large endodermic cells projecting into the gastrovascular cavity, having a large nucleus and no vibratile flagellum, in fact presenting all the characters of young ova of the gonophores. At the upper extremity of the pedicle we see one or two differentiated endodermic cells, but with no direct connexion with the gastrovascular cavity, as two or three small endodermic cells cover them. Further up, towards the base of the cavity of the gonangium, the cenosarc gives origin to lateral diverticula. One of them presents in its interior a small cavity, the cavity of the cæcum of the blastostyle, bounded by a series of endodermic cells. To the outer surface of this layer is attached a young ovum. *The intermediate lamella passes above this ovum*; and further out is the ectodermic lamella. In the upper gonophores the same conditions exist, but the ova become more and more voluminous. When the ovum is mature the tissues surrounding it are in process of atrophy. The endodermic origin of the ova is therefore evident.

Bringing together these observations and those of E. van Beneden and Bergh, I conclude that *in the family Campanularidæ the spermatozooids are developed at the cost of the ectoderm, and the ova at the expense of the endoderm.*—*Comptes Rendus*, Jan. 5, 1880, p. 43.

*On the Plants which serve as the Basis of various Curares.*

By M. G. PLANCHON.

From the data now acquired it may be regarded as established that the plants which serve as the basis of the curare poison all belong to the genus *Strychnos*. The species of other families which enter into its composition only play a secondary part.

We know of four distinct regions which are centres of the preparation of curare; and for each of them we may indicate a principal plant which of itself explains the effects of the poison. These are, in the order of the dates at which they became known:—

1. British Guiana, furnishing the curare of the Macusis Indians.

Schomburgk ascertained that the important species of this region is *Strychnos toxifera*, Schomb., accompanied by *S. Schomburgkii*, Klotsch, and *S. cogens*, Benth.

2. The very extensive region of the Upper Amazons, giving the curare of the Pebas Indians, the Javari, the Yapura, &c. The plant forming the basis of this curare was found during the expedition of M. de Castelnau, and described by Weddell under the name of *S. Castelnauana*. It is usually associated with a menispermaceous plant, probably the *Abuta*; it is the *Cocculus toxiciferus*, Wedd. MM. Jobert and Crévaux have recently brought home these species, and confirmed the statements of M. Weddell.

3. The region of the Rio Negro. The roots, stems, and leaves of the important species of this region were communicated to the author during the Exposition of 1878; and he has described them in the 'Journal de Thérapeutique.' The venation of the leaves and the structure of the stem and roots prove this plant to be a *Strychnos* which does not answer to any known species; and for it the author has proposed the name of *S. Gubleri*.

4. Upper French Guiana, furnishing the curare of the Roucouyenne and Trios Indians. The important species of this region is a plant indicated by the author in a communication to the Academy of Sciences on December 22, 1879. It is the most interesting of the two new species of *Strychnos* brought back by M. Crévaux from his recent explorations; and the author here describes it under the name of *Strychnos Crévauxii*. On the banks of the river Parou, an affluent of the Lower Amazons, it bears the name of *ourari* or *urari*; but it is perfectly distinct from the plants so designated in other regions.—*Comptes Rendus*, Jan. 19, 1880, p. 133.

#### *On the Systematic Position of the Sponges.*

By Dr. CONRAD KELLER.

At the Meeting of the Société Helvétique des Sciences Naturelles in August last, Dr. Conrad Keller communicated some observations upon the systematic position of the sponges, which he regarded as forming a third natural division (Spongozoa) of the Cœlenterata. He stated that in the spring of 1879 he had the opportunity at Naples of thoroughly observing the development of a new siliceous sponge, which he names *Chalinula fertilis*. In this species he ascertained that the sexes are separate, and that, during the period of reproduction, the female actually presents a nuptial dress, which varies from carmine-red to lilac. The ovum undergoes a complete but irregular segmentation, which results in the formation of a larva consisting first of two and afterwards of three lamellæ. The transformation of this into a young sponge could be traced with certainty; it gave origin to a form which, with the exception of the tentacles, agrees in all essential points with a young polype. Dr. Keller exhibited drawings illustrative of the details of these transformations, which he regarded as leaving no doubt that the true position of the sponges is among Cœlenterata.—*Bibl. Univ., Arch. des Sci.* December 15, 1879, p. 713.

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 28. APRIL 1880.

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XXVI.—*On some Points in the Structure of a Species of the "Willemoesia Group of Crustacea."* By S. I. SMITH, Prof. Comp. Anat., Yale Coll.

AMONG the interesting collections of marine animals made during the past two years by the fishermen of Gloucester, Massachusetts, and presented to the United-States Fish Commission for the National Museum at Washington, there are two species of Podophthalmous Crustacea of peculiar interest. One of these is a remarkable hermit-crab (*Parapagurus pilosimanus*), which I have already described\*; the other is the subject of this note, and belongs to the "*Willemoesia* group of Crustacea," which has recently been discussed by Messrs. Bate and Norman in the '*Annals*.' Of the latter species I have seen a single male only, which was taken in 250 fathoms, off the coast of Nova Scotia, north latitude  $43^{\circ} 10'$ , west longitude  $61^{\circ} 20'$ , by Capt. Thomas Olsen, of the schooner '*Epes Tarr*.' This specimen is not in very good condition, having been dried (probably after having been taken from the stomach of some fish, though there is very little evidence of digestion having begun) and the internal organs consequently destroyed; but it is still sufficient to throw considerable light upon the structural peculiarities of the group to which it belongs.

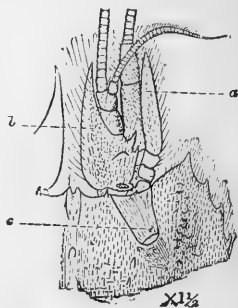
\* "*The Stalk-eyed Crustaceans of the Atlantic Coast of North America north of Cape Cod*," Trans. Connecticut Acad. v. pp. 27-138 (1879).

Of the three genera into which Bate has separated the forms of the "*Willemoesia* group," our species should be referred to *Pentacheles*; but, on account of the at present uncertain tenure of these genera, I have referred it provisionally to Heller's *Polycheles*. It is apparently very distinct from any of the Atlantic species described by Heller, Willemoes-Suhm, or Bate; but, judging from the very short descriptions given by the last author, it appears to be closely allied to his *Pentacheles auriculatus*, obtained by the 'Challenger' expedition off the Fijis. Our specimen is a male, 92 millims. long. It is described in detail in the 'Proceedings of the National Museum, Washington,' for 1879, as *Polycheles sculptus*; and I wish here to call attention to a few points in its structure only.

The anterior margin of the carapax, as seen from above, is concave in outline, so that the lateral angles are much in advance of the rostrum. About a third of the space between the median line and the lateral angle on each side is occupied by a very deep orbital sinus completely filled by a large ophthalmic lobe (fig. 1). Just behind the orbital sinus there is a smooth and evenly curved depression in the surface of the carapax, exposing a small area on the posterior part of the ophthalmic lobe.

The ventral region of the carapax on each side is divided longitudinally into three approximately equal parts by two carinæ: the outer (marking the pleuro-tergal suture?) extends from the anterior margin at the base of the antenna toward the postero-lateral margin; the inner extends along the branchial region from near the base of the first pereopod to the postero-lateral angle of the carapax. The outer of the three longitudinal regions thus marked out is divided transversely by the cervical suture; and the anterior portion (subhepatic region) is divided transversely into an anterior and a posterior lobe by a groove nearly or quite as conspicuous as the cervical. In the frontal margin of this anterior lobe and near its inner side there is a deep sinus corresponding to the orbital sinus of the dorsal surface, but not quite as wide, and open nearly to the dorsal surface, except where it is crossed by a protuberance from the ophthalmic lobe (fig. 2).

Fig. 1.

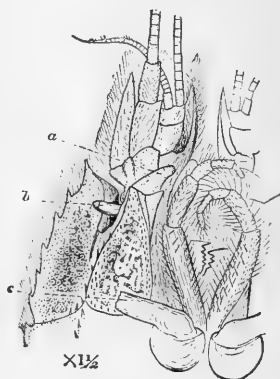


Dorsal view of the anterior portion of the right side of the carapax: *a*, antennal scale; *b*, proximal segment of antennula; *c*, ophthalmic lobe.

The dorsal surface of the ophthalmic lobe is smooth, calcareous, and opaque, and on a level with the adjacent surface of the carapax, except posteriorly, where a small oval area of the extremity of the lobe is exposed by the depression in the carapax. This oval area is thin, semitranslucent, and not calcareous, and has every appearance of being a true corneal area, although I am unable to detect any evidence of facets. The carapax along the margins of the sinus is in close contact with the ophthalmic lobe, but is not really connected with it. From the lower portion of each ophthalmic lobe there is an elongated, cylindrical and somewhat conical, but obtuse and pointed, protuberance, of which the base rests in a transverse groove in the base of the antenna, while the terminal portion extends well across the open ventral side of the orbital sinus. Upon the obtuse extremity of this protuberance there is a nearly circular area, similar to the cornea-like area at the posterior extremity of the dorsal part of the lobe.

Unfortunately the specimen is not in sufficiently good condition to enable me to determine positively in regard to the structure of these cornea-like areas; but that they are connected with the optic nerves and are sensitive to light, there is, I think, no chance for reasonable doubt. While it seems probable that all four of these areas are really faceted like the eyes of ordinary *Podophthalmia*, it is possible that they may be large, simple or nearly simple eyes, like the eyes of some *Amphipoda* and *Cumacea*. The division of the ophthalmic lobe on each side into two or more "eyes" has not, I think, before been noticed among the *Decapoda*, and is certainly an interesting fact in morphology; but it is apparently not a character of much systematic or phylogenetic value. Among the *Schizopoda*, the lamellar expansion of the ophthalmic lobes in *Amblyops*, and their broad expansion and partial union in *Pseudomma*, are quite as remarkable and apparently somewhat similar modifications; and *Ampelisca* and *Bibbys*, among the *Amphipoda*, are cases in which there are two simple eyes on each side,

Fig. 2.



Ventral view of the anterior portion of the right side of the carapax: *a*, tubular process containing the canal from the green gland; *b*, process of the ophthalmic lobe; *c*, base of the first pereopod.

while in the closely allied *Haploops* the number apparently varies in the different species.

The openings of the green glands are arranged very differently from what they are in any other group of Crustaceans known to me. Willemoes-Suhm says, of *Willemoesia leptodactyla*, that "there is no distinct opening for the so-called green glands;" but he probably overlooked it from its being in an unusual position: it is, with very little doubt, situated in a similar manner in all the allied species. The proximal segment of the antenna, in our specimen, is loosely articulated with the sternum of the antennal segment, so as to be freely movable upon it. It is very short upon the outside, but expands somewhat on the inner side, which terminates distally in a thin tubular process arising from the oral side of the segment and directed upward to a level with the dorsal side, so that, in the ordinary position of the appendages, its orifice is closed by contact with the proximal segment of the antennula. This tubular process (*a*, fig. 2) readily admits a large bristle, which can be pushed through it, round into the cavity of the segment itself. A similar process is apparently shown in one of Bate's figures of *Pentacheles enthrix* ('Annals,' vol. ii. pl. xiii. fig. 2, 1878), though I find no reference to it in the accompanying text. Bate subsequently, however, appears to allude to this same process as "the olfactory tubercle of the second or outer antennæ," though I cannot find that he anywhere alludes to Willemoes-Suhm's inability to discover the openings of the green glands.

The branchiostegites extend forward quite over the sternum of the antennary somite; and their anterior extremities are applied to the basal segments of the antennæ. The epistome is short, not extending at all in front of the bases of the antennæ, is nearly on a level with the dorsal wall of the efferent branchial passages, and on a plane above the bases of the antennæ; so that the efferent passages terminate in the space between the upturned edges of the squamiform processes of the inner sides of the basal segments of the antennulæ and just beneath the short two-spined rostrum. The anterior part of the endostome is on a plane somewhat above the plane of the epistome; but the space below is filled by the soft and fleshy labrum, which projects considerably below the raised posterior edge of the epistome, and does not differ essentially from the labrum in *Astacidæ* or *Scyllaridæ*. The other oral appendages are nearly as figured by Willemoes-Suhm for *Willemoesia leptodactyla*; one of the lobes of the first maxillipeds, however, appears to assume a function not before noticed. The inner, or endognathal, lobes of these appendages

are small and rudimentary; but there is a very large and terminally bilobed lamella, apparently representing the exognath, which extends forward considerably in front of the epistome, where its terminal lobes are somewhat upturned and serve as the lower wall of a tube from the efferent branchial opening. This lamella is continuous posteriorly with the very large epignath, which extends far back into the branchial chamber.



Fig. 3.  
Terminal portion of the second pereopod of the right side.

The fifth, or last, pair of pereopods are considerably shorter and more slender than the fourth, and subchelate (fig. 4).

The first pleopods have an imperfect articulation about a third of the way from the base to the tip; the basal portion is somewhat triquetral; and the terminal portion expands into a smooth, naked, and thin

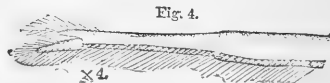


Fig. 4.  
Terminal portion of the fifth pereopod of the left side.

lanceolate lamella slightly concave posteriorly. The second pleopods are similar to the succeeding pairs, not greatly modified as in *Astacus* and its near allies. The lamellæ are narrow, lanceolate, and nearly equal in size; and the inner lamella bears the two small styliform processes usually characteristic of males among *Macrura*. The three succeeding pairs of pleopods are similar to those of the second pair; but, as usual, they all want the outer of the two styliform processes on the inner margin of the inner lamellæ.

New Haven, Conn., U. S. A.,  
Feb. 11, 1880.

## XXVII.—On the Geological Distribution of the *Rhabdophora*. By CHARLES LAPWORTH, F.G.S. &c.

### Part III. RESULTS.

[Continued from p. 62.]

(A) GEOLOGICAL.—The conclusions which may be drawn from the data now before us, as detailed in the preceding pages, arrange themselves very naturally under two distinct heads. In the first place, we shall consider the various forms of *Rhabdophora* there enumerated from the geological or stratigraphical point of view, treating of the several groups and individuals as possible indices of the systematic place of their

containing beds. In the second place we shall look upon them from the zoological or palæontological side, noting the geological date of the advent, culmination, and gradual extinction of the known families, genera, and species, and fixing approximately their individual range in Palæozoic time.

*Upper Cambrian Rocks.*

TABLE II. Showing Range of Upper Cambrian Rhabdophora.

	Malvern Hills.	Shineton Shales.	Alum Shales, Norway.	<i>Olenus</i> Skiffar, Westrogothia.	<i>Dictyonema</i> Skiffar, Scania.
DICHOGRAPTIDÆ.					
<i>Bryograptus Callavei</i> , Lapw. ....	?	*			
— <i>Kjerulfi</i> , Lapw. ....	..	..	*		
<i>Clonograptus rigidus</i> , Hall. ....	..	..	..	?	?
<i>Dichograptus tenellus</i> , Linn. ....	..	..	..	*	

The oldest Rhabdophora hitherto detected are probably the forms discovered by Mr. Linnarsson in the *Olenus*-beds of Westrogothia, Sweden. These strata are possibly of a somewhat higher antiquity than the Shineton shales of Shropshire, in which Dr. Callaway has discovered corresponding forms.

The only family of Rhabdophora as yet represented in these Upper Cambrian graptolitiferous rocks is that of the Dichograptidæ, to which the vast majority of the forms belong which mark the succeeding Arenig period. Indeed this fragmentary Cambrian graptolitic fauna appears at first sight to be essentially of an Arenig type. One prime distinction, however, can hardly be overlooked. In the Arenig formations the more simple forms, such as *Didymograptus* and *Tetragraptus*, greatly preponderate, the highly complex forms like *Dichograptus* and *Clonograptus* being comparatively rare. In this small Upper Cambrian assemblage, on the other hand, the only forms recognized belong to some of the most highly complex genera known—the British, Norwegian, and Swedish faunas agreeing precisely in this respect.



ORDOVICIAN SYSTEM (*Lower Silurian of Murchison*).(a) *Arenig Formation*.†TABLE III. Showing the Range of the *Arenig* *Rhabdophora*.

	Lower.	Middle.	Upper.	Arenig of St. Davids.	Lower.	Middle.	Upper.	Arenig of Shelve.	N. Wales.	Tyobry.	Pont Seiont.	Lower.	Upper.	Skiddaw Slates.	Norway.	Low. Grapt. Sch.	Mid. Grapt. Sch.	Point Lewis.	Riv. St. Anne &c.	Newfoundland.	Australia.
<b>LEPTOGRAPTIDÆ.</b>																					
<i>Azygograptus Lapworthi, Nich...</i>	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.
— <i>coelebs, Lapw. ....</i>	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.
<b>DICRANOGRAPTIDÆ.</b>																					
<i>Dicellograptus divaricatus, Hall. . . .</i>	.	.	r.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<b>DICHOGRAPTIDÆ.</b>																					
<i>Didymograptus affinis, Nich. ....</i>	.	.	*	.	.	.	.	*	.	.	.	*	*	.	.	*	.	.	.	.	.
— <i>arcuatus, Hall . . . . .</i>	.	.	*	.	.	.	.	*	.	.	.	*	*	.	.	*	.	.	.	.	.
— <i>bifidus, Hall . . . . .</i>	.	.	*	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>constrictus, Hall . . . . .</i>	.	.	*	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>extensus, Hall . . . . .</i>	*	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>extenuatus, Hall . . . . .</i>	*	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>fasciculatus, Nich. . . . .</i>	.	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>gibberulus, Nich. . . . .</i>	.	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>indentus, Hall . . . . .</i>	.	.	*	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>Murchisoni, Beck . . . . .</i>	.	.	.	.	.	*	*	*	.	.	*	*	*	.	.	*	*	*	.	.	.
— <i>Nicholsoni, Lapw. . . . .</i>	.	.	*	.	.	*	*	*	.	.	*	*	*	.	.	*	*	*	.	.	.
— <i>nitidus, Hall . . . . .</i>	.	.	*	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>patulus, Hall . . . . .</i>	.	*	*	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>pennatulus, Hall . . . . .</i>	*	*	*	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>similis, Hall . . . . .</i>	.	.	*	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>strictulus, Linnrs. . . . .</i>	.	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	*	.
— <i>sparsus, Hopk. . . . .</i>	*	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	.
— <i>Pantonii, McCoy . . . . .</i>	*	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>v-fractus, Salter . . . . .</i>	.	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
<i>Tetragraptus alatus, Hall . . . . .</i>	.	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>approximatus, Nich. . . . .</i>	.	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>Bigsbyi, Hall . . . . .</i>	.	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	.	*
— <i>bryonoides, Hall . . . . .</i>	*	.	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	*	*
— <i>crucifer, Hall . . . . .</i>	.	*	.	.	.	*	*	*	.	.	.	*	*	.	.	*	*	*	.	*	*

† These tables include all the forms of *Rhabdophora* published to this date (Jan. 1880) the geological horizons of which are approximately known. Several species recently described are added to those already enumerated in the preceding portions of this paper. A few are omitted altogether, either because their geological age is uncertain, or because they are of very doubtful specific identification.

TABLE III. (continued).

	Arenig of St. Davids.			Arenig of Shelve.			N. Wales.	Skiddaw Slates.		Scania.		N. America.					
	Lower	Middle.	Upper.	Lower.	Middle.	Upper.	Tyobry.	Pont Seint.	Lower.	Upper.	Norway.	Low. Grapt. Sch.	Mid. Grapt. Sch.	Point Levis.	Riv. St. Anne &c.	Newfoundland.	Australia
<i>Tetragraptus denticulatus, Hall.</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>fruticosus, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>Halli, Hopk.</i>	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>Hicksi (?) , Hopk.</i>	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>Headi, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>quadribrachiatus, Hall</i>	.	*	.	.	.	.	.	.	*	.	.	.	.	.	*	*	*
<i>Dichograptus Sedgwicki, Salt.</i>	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.
— <i>octobrachiatus, Hall</i>	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.
— <i>octonarius, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Loganograptus Logan, Hall</i>	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.
<i>Clonograptus flexilis, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>ramulus, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>Richardsoni, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>rigidus, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.
<i>Clematograptus implicatus, Hopk.</i>	.	*	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.
<i>Trichograptus fragilis, Nich.</i>	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.
<i>Temnograptus multiplex, Nich.</i>	.	.	.	.	.	.	.	.	*	.	.	*	.	.	.	.	.
<i>Schizograptus reticulatus, Nich.</i>	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.
<i>Goniograptus Thureaui, M<sup>c</sup> Coy.</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*
<b>PHYLLOGRAPTIDÆ.</b>																	
<i>Phyllograptus angustifolius, Hall.</i>	.	.	.	.	.	.	.	.	*	.	*	*	.	.	.	*	*
— <i>Anna, Hall</i>	.	.	.	.	.	.	.	.	.	.	*	.	.	.	*	.	*
— <i>iliciformis, Hall</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>stella, Hopk.</i>	*	.	.	.	.	.	.	.	.	.	.	.	.	*	*	*	*
— <i>typus, Hall</i>	.	.	.	.	.	.	.	.	*	.	*	*	.	*	*	*	*
<b>DIPLOGRAPTIDÆ.</b>																	
<i>Diplograptus dentatus, Brongn.</i>	.	.	*	.	*	*	.	.	*	*	.	.	.	u	*	*	*
— <i>inutilis, Hall</i>	.	.	.	.	.	.	.	.	*	*	.	.	.	.	*	.	*
<i>Climacograptus confertus, Lapw.</i>	.	.	*	.	*	.	.	.	.	.	.	.	.	*	*	*	.
— <i>Scharenbergi, Lapw.</i>	.	.	.	.	.	.	.	.	.	.	*	*	*	*	*	*	.
<i>Cryptograptus tricornis, Carr.</i>	.	.	.	.	r.	.	r.	r.	r.	r.	.	.	.	r.	.	.	.
— ? <i>antennarius, Hall</i>	.	.	.	.	.	.	.	.	*	*	.	.	.	u	*	.	.
— ? <i>Hopkinsoni, Nich.</i>	.	.	.	.	.	.	.	.	*	*	.	.	.	u	*	.	.
<b>LASIOGRAPTIDÆ.</b>																	
<i>Glossograptus ciliatus, Emmons</i>	.	.	*	.	.	.	*	.	.	.	.	.	.	.	.	.	.
— <i>armatus, Nich.</i>	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.
<i>Retiograptus tentaculatus, Hall.</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	*
<i>Hallograptus bimucronatus, Nich.</i>	.	.	.	.	.	.	r.	.	.	.	.	.	.	.	.	.	*
<b>RETIOLITIDÆ.</b>																	
<i>Trigonograptus ensiformis, Hall.</i>	*	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.
— <i>lanceolatus, Nich.</i>	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	.
— <i>truncatus, Lapw.</i>	*	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.

The grand characteristic of the graptolitic fauna of the Arenig rocks is the extraordinary predominance of those forms of *Rhabdophora* which compose the family of the *Dichograptidæ*. In every region where these Arenig strata have been fully investigated they have been found to be locally crowded with the feathery forms of this special group, from the simplest to the most highly complex species. Of the sixty-three forms of *Graptolites* enumerated in the foregoing Table, forty-five, or nearly three fourths of the entire fauna, belong to this single family; and if we unite with it the dubiously distinct family of the *Phyllograptidæ*, it will be found to outnumber the representatives of all the remaining families in the proportion of nearly five to one. This marked peculiarity, which gives to our Arenig fauna a special character unique among those of the Lower Palæozoic formations, is not confined to Britain alone, but is fully as characteristic of the Arenig of Scandinavia, and of North America, as well as of the antipodal regions of Australia.

Within the generally accepted provisional limits of the Arenig formation there is some evidence of a progressive change in the relative preponderance of the various genera of the *Dichograptidæ* in proportion as we ascend in the vertical series. As we have already pointed out, the more complex genera seem to have been the first to appear; and in the lowest Arenig beds they are still abundant, but they are intermixed with simple forms. In the Middle Arenig strata the highly complex and beautifully regular genera like *Clonograptus* and *Dichograptus* appear to have died out, and the prevalent complex genus in these beds is the four-armed *Tetragraptus*. In the true Upper Arenig the bifid genus *Didymograptus* is supreme. The monotonous character of the fauna of these higher beds, due to the presence of multitudes of examples of this single genus, is but slightly affected by the presence of scattered examples of irregularly compound genera, very different in their structural features from the regularly dichotomizing forms of the earlier beds.

All the regularly dividing forms of *Dichograptidæ* with more than four branches appear to have vanished before the close of the so-called Middle Arenig. There the four-armed *Tetragraptus* is most characteristic. The bifid genus *Didymograptus* is rare in the lowest beds; but its individuals increase rapidly in numbers as we ascend the succession, filling the places left vacant by the disappearing complex genera, till finally in the Upper Arenig it becomes the most prevalent and characteristic form. The rarer and irregularly branching complex genera which there accompany it seem to point to-

wards *Cænograptus*, one of the most striking forms of the distinct family of the Leptograptidæ.

From the base to the summit of the Arenig formation the Dichograptidæ are accompanied by the rarer forms of the most intimately allied family of the Phyllograptidæ. The single genus of which this family is at present composed has not hitherto been met with in true Cambrian rocks, and is unknown above the lower limit of the Llandeilo formation. Like the Dichograptidæ, its species are typical of the Arenig rocks from Scandinavia to the Antipodes. We know too little of the beautiful forms of this family to note any general change in their superficial features during this extended period. As yet, indeed, we have not collected sufficient material for the complete study of a single British species.

As a general rule, species belonging to the remaining families of the Diprionida are, in the Arenig, the rarest of fossils. Locally, however, an occasional stratum is met with in which they are tolerably abundant. Three distinct families, however, are already recognizable, all making their first known appearance almost simultaneously near the boundary line between the Lower and Middle Arenig rocks. The Diplograptidæ are represented by the whole of the three component genera; but the species are all somewhat generalized in character, and the most generalized genus, *Cryptograptus*, claims, as might have been expected, the majority of the known forms. The intermediary and provisional family of the Lasiograptidæ is represented by the bizarre genera *Glossograptus* and *Retiograptus* of Hall. The latter, which is as yet confined to the Lower Arenig of Canada and Australia, is also the most generalized genus of its family, combining structural features subsequently found separate in *Glossograptus* and *Lasiograptus*. The Retiolitidæ are represented by a single genus only, *Tetragraptus* of Nicholson, which seems likewise of a transitional character, leading through the later genus *Gymnograptus* of Tullberg into the family of the Lasiograptidæ.

Of the Monoprionida outside the dominant family of the Dichograptidæ few forms are known, a single British example of the Dicranograptidæ from the Upper Arenig of Abereiddy Bay and two species of the family of the Leptograptidæ from the corresponding strata of the Upper Skiddaw group are all that have hitherto been published from these Arenig rocks.

*Lower Arenig* (of Hicks).—The only locality where graptoliferous strata near the base of the Arenig formation have been carefully examined in Britain is at Whitesand

Bay, near St. Davids, where the few forms that have hitherto been collected are chiefly *Diplograpti* and *Cladophora*. I suspect, however, that the oldest strata of Point Levis, with highly complex *Dichograptidæ*, will be found to be on or near this horizon, as well as some of the lowest Skiddaw beds. They may eventually have to be placed at the summit of the Cambrian.

*Middle Arenig*.—To this provisional horizon the more typical Arenig beds of Skiddaw and the Lower Graptolite schists of Sweden undoubtedly belong. They appear to be marked generally by the prevalence of the genera *Tetragraptus* and *Didymograptus*, in combination with an admixture of regular and irregular complex genera of *Dichograptidæ*. The limits of this subformation are as yet undefined either above or below; but if we regard the Skiddaw and Scanian beds as provisionally typical, we find in this division few *Diprionida*, and those which are present rise upwards into the succeeding subformation.

*Upper Arenig*.—Everywhere in Britain these beds are composed of shaly strata varying in tint from light green to black. The Upper Skiddaw of the Lake District possibly includes some horizons not embraced in the more typical and Upper Arenig beds of South Wales, or in the corresponding Scanian strata that overlie the Swedish *Orthoceras*-Limestone; but in all these beds the salient character of the Graptolite fauna is the predominance of individuals of *Didymograptus*, among which the "geminiform" species *D. bifidus*, Hall, is especially common. No regularly compound genera of the *Dichograptidæ* have as yet been procured from this horizon; but the irregularly branched forms of the type of *Trichograptus fragilis*, Nich., are occasionally met with. *Diprionida* of the families noted above are present, and apparently in greater numbers than in the underlying zone. *Phyllograptidæ* are locally abundant, appearing on this horizon for the last time.

Our knowledge of the range of the Graptolites within the Arenig formation is as yet too defective to allow us to fix even the approximate range of the species of *Dichograptidæ*. Of the less-understood forms of *Diprionida* we know hardly any thing with certainty; and the few recognized zoological facts are deprived of the geological value they would otherwise possess in our catalogue by the undoubted intermixture of species derived from several distinct stratigraphical zones.

TABLE IV. Showing Range of Llandeilo Rhabdophora.

[illegible]

The collective Graptolite fauna of the typical Llandeilo beds is essentially of a transitional character. In the true Arenig strata, as we have already shown, the feathery *Dichograptidæ* and *Phyllograptidæ* preponderate to such an extent that the species of the few additional families represented occur only as sparsely scattered specimens among the hosts of individuals of *Didymograptus* and its allies. In the typical Bala or Caradoc formation, as will be shown in the sequel, these old Arenig families have utterly vanished, and the faces of the graptolitiferous laminæ are now crowded with multitudes of *Dicranograptidæ* and *Diplograptidæ*. The Llandeilo formation, as geologists provisionally define it at present, combines in its collective fauna both the Arenig and Bala types, and shows the gradual passage of the one into the other. *Phyllograptus* is absent throughout; but in the Lower Llandeilo *Didymograptus* is as densely abundant as in the Upper Arenig; while *Diplograptidæ* and *Dicranograptidæ* are very rare or only locally prolific. In the Upper-Llandeilo and the transitional Llandeilo-Bala or Glenkiln strata, on the other hand, a *Dichograptid* is the rarest of fossils, while the *Dicranograptidæ* and *Diplograptidæ* occur in countless multitudes.

*Lower Llandeilo*.—An occasional example of an irregularly compound genus of the *Dichograptidæ* has been met with in the lowest zone of the Llandeilo, as near Llan Mill &c., where I detected forms allied to *Tetragraptus* and *Goniograptus*, M'Coy; but, as in the immediately underlying beds of the Upper Arenig, the most prolific genus in the Lower Llandeilo is emphatically *Didymograptus*, M'Coy. Species with parallel and with widely divergent arms are present; but both in Britain and Scandinavia the "geminiform" species of the type of *Didymograptus Murchisoni*, Beck, occur in abundance everywhere, while the "patuliform" species of the type of *D. patulus*, Hall, are only locally present.

The black-shale beds composing the so-called Lower Llandeilo of Hicks may almost be denominated the "*Zone of Didymograptus Murchisoni*, Beck." This beautiful fossil abounds in the dark schists of the Lowest Division of the Llandeilo of Aberiddy Bay, near Whitland and Llan Mill, at Llandeilo, at Builth, and in the mining area of Shelve. It reappears in like abundance in the "*Didymograptus geminus* beds" of Scania, in Southern Sweden. In all these localities it is accompanied by many of the Upper Arenig species enumerated in the previous section, or by very closely allied forms, including representatives of *Diplograptus dentatus*?, Brongn., *Climacograptus cælatus*, Lapw., and *C. confertus*, Lapw.,

together with new and very remarkable forms of *Cryptograptus* and *Glossograptus*. In many respects this black-shale zone is most naturally regarded as the upward extension of the deep-water sediments of the Upper Arenig; and we may eventually be forced to unite it more closely with that subformation in our improved schemes of geological classification.

*Middle Llandeilo*.—In the coarse grits, sandstones, and felspathic ashes that together make up the greater part of the succeeding Middle Llandeilo subformation, *Didymograptus Murchisoni* and some of its varieties are still present, but are excessively rare. Of other forms few are known; *Diplograptus foliaceus*, Murch., and *Climacograptus Scharenbergi*, Lapw., are all that have been actually recognized in Britain; but if the *Glossograptus* zone of the Scanian Middle Graptolite schists admits of approximate parallelism with this subformation, there fall to be added many additional species, of which the commonest Swedish forms are allies of the prolific *Glossograptus Hincksi*, Hopk., and *Diplograptus rugosus* of the later Scottish Glenkiln formation.

*Upper Llandeilo*.—The strata that lie between the typical Llandeilo Limestone of South Wales and the Bala Limestone of the North are not yet sufficiently studied to allow us to fix the line of demarcation between the two formations to which these calcareous zones give their titles. As we have already pointed out, the lower strata are undoubtedly of Llandeilo age; but the larger mass of the beds lies well within the limits of Sedgwick's Bala formation. Before we reach the limestones and calcareous shales with *Ogygia Buchi* that lead up into the Upper Llandeilo formation, all the geminiform *Didymograpti* so characteristic of the underlying beds have totally disappeared; and I know as yet of no forms of *Didymograptus* that have hitherto been collected in the Upper Llandeilo of Wales. They must, however, be locally present; for patuliform species occur in the higher Glenkiln shales. *Diplograpti*, however, are abundant, especially forms of the type of *Cryptograptus tricornis*, Carr., and *Climacograptus Scharenbergi*, Lapw. Here also we meet for the first time with the elegantly symmetrical genus *Cænograptus* of Hall, so characteristic of the Glenkiln shales, and its constant and highly prolific though somewhat diminutive associate the species *Dicellograptus sextans* of Hall, which in the Glenkiln period is as numerically abundant as *Didymograptus Murchisoni* in the Upper Arenig.



TABLE V. Showing Range of Glenkiln or Llandeilo-Bala Rhabdophora.

		Scot-land.	Ireland.				Sweden.	N. America.					
	Llanfaelrhys.	Glenkiln Shales.	Stinchur Valley.	Ballygrot.	Tramore Bridge.	Balleymoney.	Six-Mile Bridge.	Scharenbergi Zone.	Norman's Kiln.	Taconic Shales.	Utica Slate.	St. Lawrence.	Nevada.
LEPTOGRAPTIDÆ.													
Leptograptus flaccidus, Hall . . . . .	*	*	*	*	*	?	*	*	?				
Amphigraptus radiatus, Lapw. . . . .	*	*	*	*	*								
Cœnograptus gracilis, Hall . . . . .	*	*	*	*	*	*	*	*	*	*		*	
— surcularis, Hall . . . . .	*	*	*	*	*								
— pertenuis, Lapw. . . . .	*	*	*	*	*								
— explanatus, Lapw. . . . .	*												
DICELLOGRAPTIDÆ.													
Dicellograptus divaricatus, Hall. . . . .	*	*	?	*									
— intortus, Lapw. . . . .	*	*	*	*									
— patulosus, Lapw. . . . .	*	*	*	*					*			*	
— sextans, Hall . . . . .	*	*	*	*	*	*	*	*	*	*		*	
Dicranograptus formosus, Hopk. . . . .	*	*	*	*	*	*	*	*	*			*	
— furcatus, Hall . . . . .	*	*	*	*	*	*	*	*	*				
— Nicholsoni, Hopk. . . . .	*	*	*	*	*	*	*	*	*				
— ramosus, Hall . . . . .	*	*	*	*	*	*	*	*	*	*	*	*	*
— ziczac, Lapw. . . . .	*	*	*	*	*	*	*	*	*				
DICHOGRAPTIDÆ.													
Didymograptus serratus, Hall. . . . .	?	?	*	*					*	*	*		
— superstes, Lapw. . . . .	*	*	*	*	?	?	?	*	*	*			
Clematograptus multifasciatus, Hall . . . . .								*					
DIPLOGRAPTIDÆ.													
Diplograptus angustifolius, Hall. . . . .								*	*				
— euglyphus, Lapw. . . . .	*	*	*	*	*	*	*	*	*				
— foliaceus, Murch. . . . .	*	*	*	*	*	*	*	*	*	*	*	*	*
— ? mucronatus, Hall . . . . .	*	*	*	*	*	?	*	*	*	*	*	*	*
— perexcavatus, Lapw. . . . .	*	*	*	*	*			*	*	*	*	*	*
— rugosus, Emmons . . . . .	*	*	*	*	*	*	*	*	*	*	*	*	*
— Whitfieldii, Hall . . . . .	*	*	*	*	*	*	*	*	*	*	*	*	*
Cryptograptus tricornis, Carr. . . . .	*	*	*	*	*	*	*	*	*	*	*	*	*
Climacograptus bicornis, Hall. . . . .	*	*	*	*	*	?	*	*	*	*	*	*	*
— cælatus, Lapw. . . . .	*	*	*	*	*		*	*	*	*	*	*	*
— Scharenbergi, Lapw. . . . .	*	*	*	*	*	*	*	*	*	*	*	*	*
LASIOGRAPTIDÆ.													
Glossograptus ciliatus, Emmons. . . . .								*	*				
— fimbriatus, Hopk. . . . .	*												
— Hincksi, Hopk. . . . .	*	*	*	*	*			?					
— spinulosus, Hall . . . . .	*	*	*	*	*			*	*				
Lasiograptus Harknessi, Nich. . . . .	*	*	*	*	*								
Halograptus bimucronatus, Nich. . . . .	*	*	*	*	*	*	*	*	?				
RETIOLITIDÆ.													
Clathrograptus cuneiformis, Lapw. . . . .	*		*					*					
— Geinitzianus, Hall . . . . .								*					

*Llandeilo-Bala or Glenkiln Shales*.—In these unplaced beds, which possibly include parts of the higher Llandeilo and Lower Bala, as these formations are defined at present, the collective fauna is essentially of the Bala type. A single patuliform species of *Didymograptus* (perhaps two) is all that remains to represent the hosts of Dichograptidæ of the Arenig age; and this becomes extinct before we reach the highest beds of the subformation. The characteristic fossil of the Glenkiln shales is *Cænograptus gracilis*, Hall, of which it may be regarded as the special zone. This well-marked fossil occurs upon the Glenkiln horizon in Britain, Scandinavia, America, and Australia; it is accompanied by some few allied species of the same genus, and more markedly by crowds of Dicranograptidæ. *Dicranograptus ramosus*, a fossil of the overlying Bala, accompanies *Cænograptus* in its range from Britain to the Antipodes, with some closely allied transitional forms of the type of *Dicranograptus formosus*, Hopk. One of the most conspicuous fossils of the zone is *Dicellograptus sextans*, which occurs in extraordinary abundance in the lower beds, and probably equals *Cænograptus* in its extended geographical range. In Scotland and Wales, and in the Norman's-Kiln beds of North-east America, it is also associated with some closely allied forms, representative of *Dicellograptus divaricatus*, Hall.

Diplograptidæ are everywhere abundant. *Diplograptus rugosus*, Emm., is one of the commonest species; and the beautiful form *D. euglyphus* (? *D. putillus*, Hall) is locally prolific. *D. foliaceus*, Murch., is always present, but is less abundant than in the succeeding Bala-Caradoc beds. *Cryptograptus tricornis*, Carr., is frequently seen in several varieties, and the peculiar form *D. perezcavatus*, Lapw. But the species most commonly met with are undoubtedly those of the genus *Climacograptus*. *C. cælatus*, Lapw., *C. Scharenbergi*, Lapw., and *C. bicornis*, Hall, are all present, the latter in many peculiar subspecific forms.

Of the Lasiograptidæ there are several species; and the members of this family are more abundant in this zone than upon any other horizon hitherto detected in Britain. *Lasiograptus costatus*, Lapw., a possible variety of *L. Harknessi*, Nich., is abundant in the south of Scotland and in the north of Ireland. The provisional genus *Hallograptus* of Carruthers, with its scopulate reproductive appendages, is as yet wholly confined to this zone, where it has been met with in Scotland, Ireland, and North America. *Glossograptus*, Emm., here presents us with some of its latest species; their highly

spinose polyparies are not uncommon even in the highest Glenkiln.

The Retiolitidæ are among the rarest of the Glenkiln fossils in Britain and America, where the lattice-like genus *Clathrograptus*, Lapw., is all that represents the family upon this horizon. In Sweden, however, the extraordinary genus *Gymnograptus* of Tullberg, which points in the direction of the ancient *Trigonograptus*, Nich., is so abundant in strata hardly, if at all, inferior to the lowest Glenkiln beds as to give its name to the containing zone.

The zoological features of this British Glenkiln zone and its Irish and American representatives are so unique, and at the same time are so invariable throughout its extraordinary range, that the Australian strata with *Cænograptus gracilis*, Hall, &c., may be assigned with tolerable certainty to this zone, which, like the older Arenig and Lower Llandeilo zones, will probably be proved to have had a geographical extension that was worldwide.

[To be continued.]

XXVIII.—*New South-American Coleoptera, chiefly from Ecuador.* By CHARLES O. WATERHOUSE.

THE species described in this paper were, with a few exceptions, collected by Mr. Buckley in Ecuador, chiefly in the neighbourhood of Chiguinda and Sarayacu. The specimens are all in the British-Museum collection.

Cicindelidæ.

*Oxychila glabra*, n. sp.

Nigra, nitidissima, palpis antennisque testaceis, his basi nigris, sin-  
gulis elytris V flavo notatis, femoribus rufis apice nigris, tibiis  
tarsisque testaceis.

♂. Long. 9 lin.

A glabrous species resembling *O. nigro-ænea*, Bates, but with shorter elytra and narrow labrum. Head lightly transversely impressed behind the eyes, with numerous, short, longitudinal wrinkles forming a band between the eyes. Labrum narrowed and acuminate anteriorly, with no distinct denticulations laterally. Palpi pale testaceous. Thorax rather shorter than in *O. nigro-ænea*, rather more constricted in

front, more narrowed behind; the disk more convex, almost swollen into a tubercle laterally. Elytra very strongly punctured at the base, sparingly and more obscurely punctured beyond the middle, scarcely sinuous at the apex, the sutural angle very slightly obtusely dentiform; each elytron has a slightly raised yellow V-shaped spot, the side nearest the suture the shorter; there is a distinct impression within the shoulder, another near the suture, a slight one before the yellow spot; and the posterior declivity is also much impressed. The antennæ are testaceous, with the four basal joints black, the extreme base of the fourth is yellowish.

*Hab.* Macas.

### Carabidæ.

#### *Calophæna alboguttata*, n. sp.

Nigra, nitida; elytris cyaneis, fortiter striatis, ad apicem truncatis, vix spinosis, guttis quatuor albis notatis.

Long.  $6\frac{1}{2}$  lin.

Completely resembles *C. aculeata*, Chaud., in colour, size, and form, but has the sutural angle of the elytra not prolonged into an acute spine. The elytra appear to be a little longer; the striæ are very deep, the intervals very convex; the spots are small; the apex of each elytron is truncate; the truncature is not straight, but slightly sinuous; its outer angle acute, the sutural angle acute but scarcely produced.

*Hab.* Copataza River.

### Cucujidæ.

#### *Palæstes nigriceps*, n. sp.

Niger, nitidus, thorace femoribusque ochraceis, elytris dimidio basali flavis.

Long.  $5\frac{1}{2}$ – $7\frac{1}{2}$  lin.

This species resembles *P. bicolor* in form, but differs in having the head and scutellum black. Besides this difference of colour it is distinguished by having the thorax more angular in the middle of the front margin, and the sides have not the deep incision immediately before the posterior angles as in *P. bicolor*. The scutellum is a little less transverse. The impressed line on the metasternum is continued to the front; in *P. bicolor* it appears to be always abbreviated. The femora have the extreme base and apex black.

I have only seen the male of this species, which has the mandible developed in the same way as in *P. bicolor*.

*Hab.* Chiguinda.

*Palæstes tenuicornis*, n. sp.

Flavus, nitidus; antennis gracilibus nigris, apice fuscis; elytris plaga communi, tibiis tarsisque nigris.

♂. Long.  $4\frac{1}{2}$  lin.

This species is very close to *P. bicolor*, and is similarly coloured, except that, instead of having the apical half of the elytra black, there is only a large spot common to both elytra, leaving the margins yellow; the mandibles and clypeus are also yellow. Besides the coloration, this species differs in having the antennæ decidedly more slender and relatively longer; this is the more apparent when comparing the apical joints. The thorax is similar in form, but is merely sinuous at the sides, without denticulations.

*Hab.* Sarayacu.

## Rutelidæ.

*Spodochlamys mirabilis*, n. sp.

Oblonga, brunnea, æneo tincta, supra dense fortiter punctata, subtus nitida; pygidio dense asperato, fulvo hirsuto.

♂. Thorace medio tuberoso, lateribus explanatis; humeris dente acuto armatis; femoribus anticis subtus ante apicem dente magno apice hamato; tibiis anticis elongatis, ante medium curvatis.

♀. Thorace simplici, fortius punctato; humeris obtusis; tibiis anticis brevibus obtuse tridentatis.

Long. 20 lin., lat. 11 lin.

♂. Head, thorax, and scutellum very densely and strongly punctured, the narrow interspaces or rugulæ on the thorax with fine punctures; clypeus not quite twice as broad as long, rounded in front, the margin finely reflexed. Thorax twice as broad as long, semicircularly emarginate in front, bisinuate at the base; the anterior angles acute and a little porrect; the disk raised near the base; the sides impressed above and expanded, strongly angular rather behind the middle. Elytra light brown, more or less tinted with green in the punctuation, which is close, strong, and irregular, coarser at the base, fine at the margins. Body beneath and legs pitchy, tinted with æneous; the metasternum densely punctured; the abdomen sparingly punctured. Anterior femora with a strong flattened tooth near the apex, the apex of the tooth acute and hooked: anterior tibiæ very long, narrow at the base, curved inwards rather before the middle, the apical portion flattened and broader, with three teeth on the outer edge, the upper one obtuse.

♀. More convex than the male, and presenting nothing remarkable in form; broadest behind the middle of the elytra,

gradually narrower anteriorly. The thorax broadest at the base, gradually narrower anteriorly, obliquely narrowed just before the anterior angles, which are acute; the posterior angles obtuse; the whole surface very strongly and densely punctured. Elytra more yellow-brown than in the male, the punctuation rather more distinct.

*Hab.* Chiguinda.

### Dynastidæ.

#### *Lycomedes Buckleyi*, n. sp.

Nigro-piccus, supra fulvo-furfurosus.

♂. Capite cornu erecto apice tridentato, thorace disco lamina erecta antice concava instructo.

♀. Capite simplici, thorace crebre punctato.

Long. 16 lin.

This species has the broad form of *L. Burmeisteri*, Waterh. (Cist. Ent., ii. 1879, p. 422, pl. ix. f. 1), but the floury clothing is of a paler colour.

♂. Ocular canthus simple next to the eye (not projecting laterally as in *L. Burmeisteri*), but furnished in front with a small sharp tooth, which is directed forwards. The cephalic horn is erect, very slightly curved, expanded at the base on each side into a triangular flat tooth; the horn itself is somewhat enlarged at the apex, where it is divided into three sharp teeth, two in front and one behind them. The thorax is distinctly more angular at the sides than in *L. Burmeisteri*; the discoidal lamina is erect, flattened, subparallel, obtuse at its apex, slightly concave in front.

♀. More depressed than the male, with the head and thorax unarmed, the latter shining, coarsely and thickly punctured, the punctures filled with the floury substance. It scarcely differs from the female of *L. Burmeisteri*; but the sides of the thorax are a little more angular, and the posterior angles more obtuse. The only tangible difference, however, is in the form of the ocular canthus, which in *L. Burmeisteri* has its front margin straight, its side making with it an angle less than a right angle. In *L. Buckleyi* it is narrower, entirely oblique, a little projecting where it joins the angle of the clypeus, slightly sinuate in the middle, and rounded off posteriorly.

*Hab.* Chiguinda.

### Prionidæ.

#### PROTORMA, n. gen.

General appearance of *Navosoma*, but with the thorax

approaching that of *Strongylaspis*. It differs from the latter in the following points:—Eyes with scarcely a trace of emargination in front. Antennæ reaching to about the middle of the elytra; the apex of the third joint and the following joints longitudinally rugulose, opaque. Thorax trisinate in front. Scutellum not convex, rounded posteriorly. Elytra each with four costæ. Abdomen shining. Prosternal process scarcely arched, produced posteriorly.

The specimen from which these characters are taken is a female.

*Protorma scabrosa*, n. sp.

Ferrugineo-fusca, rugosa; thorace transverso, antice oblique angustato, lateribus crenulatis, ante basin dente valido armatis, dein oblique sinuatis, et juxta basin dente parvo acuto; elytris rugosis, singulis costis quatuor.

Long. 17 lin.

Dull rusty brown, the head and thorax rather darker; the body beneath pitchy black. Head, thorax, and basal joint of the antennæ densely and strongly rugose. Thorax not quite twice as broad as long, not very convex, very obliquely narrowed anteriorly, the side crenulate, the little teeth having a tendency to arrange themselves in pairs; the strong tooth before the posterior emargination not so sharp as in *Navosoma scobinatum*, the emargination deeper, with a small tooth just before the base; the base sinuate on each side, rather distinctly lobed in the middle. Scutellum finely rugose, gently impressed in the middle. Elytra at the base as wide as the widest part of the thorax, gradually becoming broader to the posterior two thirds, then arcuately narrowed towards the apex; the sutural angle with a very small tooth, densely and rugosely punctured, the base rugose; each elytron with four costæ, the first and second not extending to the apex, the third not so conspicuous, shorter than the others; the fourth sublateral, commencing below the shoulder and extending nearer to the apex than the others; epipleural fold with about the basal half channelled. Metasternum and parapleura densely and rather finely punctured, finely pilose. Abdomen shining, rather finely and not very closely punctured; the two basal segments somewhat opaque and more closely punctured towards the sides. The legs very rugose, the posterior femora above rather less so. Tarsi with the basal joint about one third longer than broad, much shorter than in *N. scobinatum*.

*Hab.* Sarayacu.

*Mallaspis Buckleyi*, n. sp.

Obscure olivacea; antennis læte violaceis, articulationibus articulisque apicalibus rufo-flavis, thorace fortiter punctato, lateribus dentatis; elytris rugosis, ferrugineis, basi olivaceo tinctis.

♂. Long. 26–33 lin.

♀. Long. 30–32 lin.

This species closely resembles *M. scutellaris* in form, colour, and appearance, but differs in the following particulars:—Thorax in both sexes more strongly punctured, the lateral denticulations less numerous and more prominent. The transverse ridges of the prosternum are very strong; and all the punctuation on the underside is much stronger, especially on the sides of the metasternum. The abdomen is olivaceous and densely punctured; in *M. scutellaris* it is tinged with pitchy, is less punctured, more shining, and in the female is almost smooth. Besides these differences, the female differs in having the antennæ longer, and the third to eighth joints are nearly parallel instead of being elongate-elliptical as in *M. scutellaris*.

*Hab.* Sarayacu.

*Udeterus elegans*, n. sp.

Flavus; capite, thorace, scutello, epipleuris elytrorumque apice piceis, antennis corpore longioribus.

♀. Long.  $7\frac{1}{2}$  lin.

General appearance of a *Myzomorphus scutellatus*, Sallé, ♀, but with the antennæ longer than the whole insect, and with more acuminate elytra, &c. Head, thorax, and scutellum very densely and rather finely granulose punctate. Antennæ pale pitchy, shining; the second joint small but well developed, the third, fourth, and fifth long and slender, the sixth to tenth joints having their apical angle produced into a rather long sharp process, that of the sixth joint smaller than the others, the ninth, tenth, and eleventh joints longitudinally impressed on their outer side above. Thorax not quite so strongly transverse as in *M. scutellatus*, the surface more uneven, the lateral spine rather more forward, rather more prominent and very acute at its apex; the base sinuate on each side and with a rather broad arcuate lobe in the middle, over the base of the scutellum. Elytra coarsely and very closely punctured, nearly as long as the abdomen, rapidly narrowed from below the shoulders, narrowed from the inner side as well as the outer; the apical angle rather acute, infusate. Prosternal process longer and more parallel than in *M. scutellatus*, a little narrowed at the apex. Metathoracic



episterna nearly as in that species, narrowed posteriorly. Metasternum very closely and delicately punctured, finely pilose. Abdomen not very thickly punctured. Legs shining, sparingly punctured.

*Hab.* Chiguinda.

There is a little doubt to which genus this species should be referred. *Udeterus*, Thoms., is founded on a male example; and the present species may be a female of an allied species; Thomson's figure, however, does not represent any lobe at the base of the thorax—a character almost of generic importance in this case. *Themnesthes*, Bates (Ent. Mo. Mag. xii. p. 51), has the thorax of my species, agreeing in the lateral spine and basal lobe; but the metathoracic episterna do not differ from those of *Myzomorphus*, and cannot certainly be said to be "parallelogrammical" as in *Themnesthes*. The second joint of the antennæ is distinct in all three insects.

#### EPISACUS, n. gen.

General form of *Calloctenus*, but broader. Antennæ of male scarcely reaching beyond the apex of the elytra; the third to tenth joints with the anterior angle produced into a moderately long acuminate process; the eleventh joint very long, very narrow at the base, and gradually becoming wider to a little before the apex, where it is suddenly smaller, giving the appearance of a twelfth joint. Thorax strongly transverse, obliquely narrowed anteriorly; the posterior angles acute, slightly prominent. Scutellum transverse, rounded posteriorly. Elytra a little wider than the thorax, moderately narrowed to the apex, which is obtuse, the outer angle rounded, the sutural angle acute. Prosternal process conical, scarcely produced beyond the coxæ, meeting a nearly similar process of the mesosternum. Metasternum with a deep longitudinal impression. Episterna very broad, but narrower posteriorly. The head, thorax, and body beneath with long pile.

The form of the sterna and the transverse scutellum at once separate this from *Calloctenus*.

#### *Episacus pilosicollis*, n. sp.

Olivaceo-æneus; capite thoraceque fulvo-pilosis; clytris nigris, purpurascens, dense fortiter punctatis, postice velutinis, lineis nonnullis elevatis nitidis.

Long.  $8\frac{1}{2}$  lin.

Thorax twice as broad as long, obliquely narrowed from the posterior angles to the front, impressed on the disk, rather

finely and very closely punctured, gently emarginate in the middle of the front margin, the posterior angles moderately acute and slightly prominent; the base oblique on each side, gently lobed in the middle. Scutellum transverse, rounded behind, impressed, finely punctured. Elytra at the base one sixth wider than the thorax, about  $2\frac{1}{4}$  times as long as broad, narrowed posteriorly, obtuse at the apex, black with a purple tint, velvety (except at the base), very closely and strongly punctured; each elytron with several fine shining lines, two of which on the disk unite posteriorly and are continued to the apex as a single one. Metasternum very thickly and delicately punctured. Abdomen shining, rather strongly and not very thickly punctured.

*Hab.* Chiguinda.

### Cerambycidæ.

#### *Coccoderus sexguttatus*, n. sp.

Elongatus, parallelus, pallide rufo-brunneus; elytris (basi ipsa excepta) testaceis, maculis eburneis utrinque tribus; capite thoraceque rugoso-punctatis, hoc tuberculis nigris nitidis, duobus dorsalibus, alteris marginalibus; antennis inermibus.

Long. 18 lin.

Antennæ nearly reaching to the apex of the elytra; the third and four or five following joints angular at their apex, but not spined. Head and thorax densely rugose, the latter more strongly so, with a black tubercle on each side of the disk anteriorly, and two black tubercles at the side; the thorax is obliquely narrowed in front of the anterior lateral tubercle, strongly constricted at the base. The elytra are pale testaceous, except at the extreme base (where they are tinted with brown), shining; each with an ovate yellowish ivory spot in the middle of the base, a second rather before the middle, with a brown dot joining above, and a third rather longer spot some distance from the apex, this has a brown dot joining it above and below; the apex has two sharp spines, of which the outer one is the stronger.

*Hab.* Chiguinda.

#### *Criodion pictum*, n. sp.

Nigrum, nitidum; elytris lævibus, apice quadrispinosis, flavo-testaceo variegatis.

Long. 17 lin.

Shining black. The elytra scarcely tinged with pitchy, with some very fine, delicate, rather distant punctures; each elytron has a broad zigzag pale yellow stripe occupying the

greater part of the elytron, but leaving a triangular spot at the scutellum united to a spot under the shoulder, a spot on the margin about the middle, a large spot on the suture behind the middle, and a semicircular patch on the margin at the apex, nearly black; at the apex are two acute spines. The head is clothed with deep-yellow silky pubescence, with a smooth lanceolate ridge between the eyes; the antennal tubercles are very depressed. Antennæ reaching a little beyond the apex of the elytra; the basal joint very strongly but not thickly punctured; the third joint has a few smaller punctures, the basal joints have some long pale hairs; the grooving of the joints is very slight, and commences at the apex of the sixth joint. Thorax with an ovate, smooth, raised spot in middle, two round ones in front of this, and three irregular smooth places on each side; the intervals clothed with deep-yellow silky pubescence, in which are scattered large deep punctures. Outer angle of the intermediate tibiæ slightly dentiform.

*Hab.* Gualaquiza.

*Criodion plagiatum*, n. sp.

Nigrum, nitidum; capite thoraceque rugosis; elytris piceo-nigris, subtilissime punctulatis, plagis quatuor sordide flavis, angulo suturali spina minuta.

Long. 18 lin.

Head very strongly, closely, and rugosely punctured; antennal tubercles well developed, divided by a deeply impressed line, their internal angle elevated and acute. Thorax one sixth broader than long, subcylindrical, constricted at the base, very strongly and closely rugose. Scutellum clothed with grey pile. Elytra not quite so shining as in the preceding species, very delicately punctured, the sutural angle only with a very small spine; each elytron has an irregular-shaped, oblique, yellow patch before the middle, touching the margin but not the suture, and a second elongate parallel spot or stripe near the margin, reaching from a little behind the middle to the apex. The antennæ are considerably longer than the whole insect; the basal joint is closely and strongly punctured; the third and fourth joints are very finely, closely, but distinctly punctured, with a few large punctures here and there. The outer apical angle of the intermediate tibiæ is obtuse.

*Hab.* Gualaquiza.

Allied to *C. dorsale*, Thoms., but with longer antennæ, more cylindrical thorax, more pointed antennal tubercles, &c.

*Haruspex lævifemoratus*, n. sp.

Piceo-fuscus, subopacus; thorace confertim rugoso-punctato, singulis elytris vitta mediana lata nigra, costaque flava (postice abbreviata) et in costa macula nigra; femoribus posticis intus lævibus, ad apicem solum punctis impressis.

Long. 7 lin.

Very close to *H. brevipes*, White, and only differs as follows:—Thorax a trifle longer, more evenly convex, more evenly arcuate at the sides. Elytra coloured in the same way; but the yellow costa is more distinct, the yellow colour is not suffused on the inner side, except a spot at its apex; the spines at the apex (both the sutural and outer ones) are more developed. The femora are more swollen, and the posterior ones are smooth on the inner side, except a few punctures at the apex.

*Hab.* Sarayacu.

*Polyschisis rufitarsalis*, n. sp.

Nigra, subvelutina, opaca; antennarum dimidio apicali, tarsis elytrisq. rufo-ochraceis, his ad humeros nigris.

Long. 12 lin.

This species so closely resembles *P. hirtipes* that it might easily be mistaken for it. It differs, however, in having the tarsi yellowish red. The lateral projection of the thorax is, moreover, a little more prominent; and the angle at this part is less obtuse, *i. e.* the side behind the tubercle makes with the side before the tubercle a less obtuse angle than in *P. hirtipes*.

*Hab.* Sarayacu.

## PANCHYLISSUS, n. gen.

Muzzle moderately prolonged. Head with a very small tooth-like projection behind the eye. Antennæ as long as the whole insect; the first joint elongate obconic; the third joint distinctly longer than the fourth; the apical joints flattened but scarcely widened. Thorax evenly convex, rounded at the sides, margined at the base, impressed above at the scutellum. Scutellum very long and narrow, acuminate. Elytra elongate, subparallel, obtusely rounded at the apex. Prosternal process moderately broad, a little raised posteriorly, obtuse, concave behind. Mesosternal process moderately broad, thick, lamelliform, obtuse, concave below in front. Four anterior femora considerably swollen before their apex. Tarsi of *Lissonotus*, but the posterior pair rather more elongate.

Evidently allied to *Lissonotus*, but with more linear antennæ, longer muzzle, elongate scutellum, longer and more parallel elytra. The general form calls to mind some *Sphænothecus*; but the structure of the antennæ and the characteristic tubercle behind the eyes show its affinity with *Lissonotus*.

*Panchylissus cyaneipennis*, n. sp.

Niger, politus, nitidissimus; thorace sanguineo, medio macula rotundata nigra; elytris cyaneis, pectore abdomineque sanguineis.

Long.  $9\frac{1}{2}$  lin.

Forehead with a rather deep longitudinal impression between the antennæ. Thorax a little broader than long, convex, evenly rounded at the sides, narrowed in front, a little narrowed before the base, with a few clear punctures scattered over the disk. Elytra deep purplish blue, with close but extremely obscure punctuation; the apex obtuse, finely fringed with black pile.

*Hab.* Sarayacu.

*Distenia humeralis*, n. sp.

Supra æneo-viridis, subtus ænea; thorace rugoso, lateribus spina acuta instructis; elytris fortiter, dense, irregulariter punctatis, postice subtiliter dense punctatis, humeris vitta brevi coccinea, sutura, marginibus strigaeque obliqua post medium griseo-pubescentibus; antennis nigris, articulis basi griseo-pilosis.

Long.  $6\frac{1}{2}$  lin.

Head rugose above. Antennæ much longer than the whole insect, slender, blackish; the basal joint tinted with æneous, subcylindrical, densely rugose; the other joints grey at the base, black at the apex. Thorax densely rugose, strongly constricted in front and before the base, angular in the middle of the side and furnished with a short spine. Scutellum clothed with whitish pubescence. Elytra wider than the thorax at their base, much narrowed posteriorly, bluish green, very strongly, densely, and irregularly punctured for nearly two thirds their length, at which point there is an oblique narrow streak of white pubescence; the surface beyond this is finely punctured; each clytron has an elongate red spot near the shoulder; the outer apical angle has a strong tooth. Femora unarmed.

*Hab.* Chiguinda.

The apical joint of the palpi is securiform, the prosternal process is less narrow than is usual, the claw-joint of the tarsi is very short, and the femora are unarmed at their apex.

These characters may hereafter prove to be of generic importance.

*Cometes apicalis*, n. sp.

Cæruleus; elytris æneo-viridibus, dense fortiter punctatis, apicibus extus sanguineis.

Long.  $6\frac{1}{2}$  lin.

Antennæ a little longer than the whole insect; the basal joint (for the genus) rather slender, very elongate, narrowed and bent at the base, rugosely punctured; the following joints slender, of equal thickness throughout, with no long pubescence. Head moderately thickly punctured. Thorax shining, obscurely punctured, with four shining, very slightly raised tumours on the disk, two on each side, strongly constricted at the base, more so in front, the sides with a conical projection in the middle. Elytra green, very slightly narrowed posteriorly, densely, very strongly, and irregularly punctured; the suture blue; the apex margined with orange-red, with no spine. Femora nearly linear; tarsi slender.

*Hab.* Medellín.

This species is doubtfully referred to *Cometes*; it differs in having the antennæ more slender than is usual, and without long pubescence. The femora are nearly linear, very long; and the tarsi are slender. On the other hand, the elytra are not acuminate as in *Distenia*, and the antennæ do not diminish in thickness towards the apex.

**Lamiidæ.**

**CALLIPHENGES, n. gen.**

Metallic. General form of *Colobothea*, but with the thorax rather narrowed posteriorly, and with an acute, small, lateral spine rather behind the middle. Elytra elongate, regularly narrowed posteriorly, without any lateral carina; the apex truncate, with its outer angle produced into a strong diverging spine. Femora a little thicker in the middle, not pedunculate. Prosternal process very narrow, arched. Mesosternal process a little broader, not nearly so broad as in *Colobothea*, more perpendicular in front.

This genus should follow *Colobothea*.

*Calliphenges cuprascens*, n. sp.

Læte cupreus, viridi-micans, nitidissimus; antennis corpore longioribus, apicem versus nigrescentibus; thorace subcylindrico, post medium paulo angustiore, parce fortiter punctato, lateribus spina acuta; elytris thorace latioribus, postice angustatis, cupreis,

parce fortiter punctatis, guttis nonnullis albis notatis, sutura virescente, apice truncato, angulo externo spina acuta valida armato, singulis elytris costa sat elevata basi haud attingente.

Long. 5 lin.

Bright coppery, the middle of the elytra and the sterna shining with bright green. The basal joint of the antennæ is stout, subcylindrical, narrowed only at the extreme base, not reaching to the base of the thorax; the third joint is one quarter longer than the first, slender; the fourth is about the same length as the first; the following joints gradually become shorter. The head is smooth in front, with a line of white pubescence on each side; there are some strong punctures behind the eyes. The thorax is as long as broad, subcylindrical, scarcely constricted before the middle, a little narrower behind the small sharp lateral spine, with strong punctures scattered over the surface; near the base there is a strongly impressed transverse line, terminating at each end in a deep fovea. The elytra are one third broader than the thorax, regularly narrowed posteriorly, with no lateral carina, but with a strong one commencing near the base and terminating in the apical spine; each elytron has five small white pubescent spots within the carina, and two or three oblique white streaks about the middle of the elytron. The metasternum is green, smooth, with some large punctures at the side. The abdomen is bright coppery, smooth.

*Hab.* Chiguinda.

ITES, n. gen.

Antennæ reaching a little beyond the middle of the elytra; the basal joint robust, elongate; the second joint much more slender, two thirds the length of the first, sparingly pilose; the third a little shorter than the second; the following joints gradually diminishing in length. Eyes almost completely divided. Thorax transverse, a little constricted before and behind the middle. Elytra expanded from the shoulders, arcuately narrowed posteriorly to the apex; resembling in general outline some species of *Dolichotoma* (Cassididæ), without costæ, but with shoulders obtusely raised, velvety. Prosternal process extremely narrow; the mesosternal moderately narrow, declivous in front. Tarsi broad; the claws fissile.

This remarkable insect, although clearly allied to the *Amphionychi*, differs in having the second joint of the antennæ elongate and a little longer than the third. To suppose that the second joint is imbedded in the apex of the first, and that what I have termed the second joint is really the third, would

involve nearly as much difficulty, as there would then be twelve joints.

I propose to place it before *Clythraschema*.

*Ites plagiatus*, n. sp.

Niger, velutinus; macula post oculos, thorace vitta laterali, plagaque in singulis elytris coccineis.

Long. 8 lin., lat. elytr. 5 lin.

Black, velvety, with a dense short fringe round the margin of the elytra; the antennæ, face, abdomen, tibiæ, and tarsi clothed with silvery-grey silky pubescence. Head with an impressed line on the vertex. Thorax transverse, a little more constricted behind than in front of the middle, convex, smooth on the disk, with a few punctures at the base. Elytra with the shoulders obtuse and raised; with a fringe of dense black pile on the suture near the scutellum; the expansion commences at the base of the elytra, and nearly attains its greatest width within the basal sixth; thence it becomes a trifle wider, and from the middle to the apex is gradually narrowed; each elytron has a scarlet patch, somewhat semicircular in form, extending from below the shoulder to near the apex, leaving the margin narrowly black.

*Hab.* Gualaquiza.

*Lycidola flavofasciata*, n. sp.

Nigra, nitida; thoracis lateribus, coxis, femorumque basi flavis; elytris cyaneis, humeris fasciæque lata flavis.

Long.  $5\frac{1}{2}$  lin., lat. elytr.  $3\frac{3}{4}$  lin.

This species is close to *L. simulatrix*, Bates, which it resembles in its flat semicircularly dilated elytra. Thorax moderately thickly and rather strongly punctured, a little narrowed in front, impressed above at the base. Elytra at their base only a little wider than the thorax, expanded immediately below the shoulders, rather thickly and distinctly punctured at the base; each with four costæ, the second and third uniting before the apex, the fourth on the lateral expansion; with a triangular humeral spot and broad fascia behind the middle yellow, the fascia somewhat dentate above and below.

*Hab.* Cuença, Ecuador (*Fraser*).

*Lycidola felix*, n. sp.

Nigra; elytris cyaneo-purpurascens, latissimis, fascia media dentata guttis nonnullis ante medium flavis.

Long.  $8\frac{1}{2}$  lin.

Antennæ with the fourth joint distinctly thicker than the



third, densely hirsute. Thorax with rather long fine hairs, strongly and rather thickly punctured, distinctly broader at the base than in front, with a swelling at the side rather behind the middle. Elytra purple steel-blue, at the base distinctly wider than the thorax, suddenly expanded immediately below the shoulders, much rounded at the sides, rather thickly and finely punctured near the base, towards the apex and the lateral expanded portion finely frosted; with an undulating deep-yellow median fascia; each elytron has four well-marked costæ (the fourth being on the expanded portion, entire), the second and third are united before the apex, but are continued to the apex by a single one; there is a yellow spot on the margin just above (and united with) the fascia; and there are two or three small yellow spots on the costæ on a level with the lateral spot.

This species has the elytra much more suddenly expanded below the shoulders, and more rounded at the sides than any species of the genus known to me.

*Hab.* Chiguinda.

*Lycidola retifera*, n. sp.

Nigra, subtilissime pubescens; thorace lineis quatuor fulvis; elytris postice bene ampliatis, depressis, fulvis, triente apicali guttisque numerosis nigris.

Long. 7 lin., lat. elytr. 4 lin.

Third and fourth joints of the antennæ equal, and scarcely longer than the first, thickened and finely pilose, the following joints together as long as the first four taken together, sparingly pilose. Clypeus and base of the mandibles fulvous. Thorax a little broader than long, slightly narrowed in front, straight at the sides, rather thickly punctured, with a fulvous line on each side, and sometimes with two fulvous lines above. Elytra at the base a little broader than the thorax, evenly but very slightly convex, enlarged immediately below the shoulders, attaining their greatest width at the middle, evenly rounded at the sides (rather less so in the male); the basal two thirds fulvous with black spots; each elytron has four lines, representing the usual costæ, but which are only raised at the apex; the intervals have numerous transverse lines, so that the elytron presents five lines of round or ovate black spots, the ground-colour being black; all the surface is rather closely and strongly punctured.

*Hab.* Chiguinda.

In general appearance this species much resembles *Themistonoë reticulata*, below described. A species of *Calopteron* in the same collection reproduces the same coloration.

*Lycaneptia antiqua*, n. sp.

Nigra; capite fulvo, macula pone oculos nigra; thorace fulvo, lateribus vittis duabus fuscis; elytris fulvis, ante medium plus minusve infuscatis, apice late cyaneo-nigro.

Long. 9 lin., lat. elytr. 5 lin.

Third joint of the antennæ a little more than twice as long as the first, thick and densely fringed; the fourth joint the same length as the first, thick and densely fringed; the following seven joints together scarcely longer than the first and second together. Head with a fine impressed line on the vertex. Thorax a little narrowed anteriorly, subcylindrical, the pubescence forming a fine mesial ridge, on each side of which, at the base, there is a dusky spot; at the sides there are two blackish stripes, almost confluent. Elytra with prominent rectangular shoulders; the expansion is at first gradual, but more rapid towards the apex, much rounded externally, the sutural angle rounded; the basal two thirds are fulvous yellow, with dusky brown in the intervals, leaving a narrow fulvous band before the apical third, which is nearly black; each elytron has two very fine, partially incomplete dorsal costæ; the humeral costa is very strong and complete; and there is a very strong complete costa on the lateral expansion. The coxæ and the extreme base of the femora are yellow.

*Hab.* Brazil.

Nearly allied to *L. togata*, Klug, but rather differently coloured and with the seven apical joints of the antennæ together not equalling a quarter of the total length of the antennæ.

*Themistonoë reticulata*, n. sp.

Nigra; thorace dorsaliter fulvo-flavo, linea mediana nigra; elytris postice bene ampliatis, fulvo-flavis, ad apicem late purpureo-nigris, reticulatis, singulis costis tribus.

Long.  $7\frac{1}{4}$  lin., lat. elytr.  $4\frac{1}{4}$  lin.

Antennæ finely pilose, the third joint thickened (especially at the apex), with more dense pilosity at the apex. The upper part of the forehead and a line behind each eye are obscurely tinted with dirty yellow; there is a fine impressed line on the vertex. The thorax is a little broader than long, a very little narrower in front than behind, very slightly constricted before and behind the middle; rusty yellow above, with a mesial black stripe, and a dusky spot on each side of it. Elytra at the base one quarter broader than the thorax, widened immediately below the shoulders, gradually becoming

broader to near the apex, where they are two and a half times as broad as at the base, rather flattened posteriorly, where they are much rounded, not deflexed at the sides; fulvous yellow except the apical fourth, which is purple-black; each elytron has three costæ, the second and third of which both arise from the shoulder, between the first and second an interrupted costa may be traced at the base; the intervals, and especially the lateral expanded portion, are strongly reticulate, the ground-colour being more or less grey, making the yellow reticulations very conspicuous; in the apical portion the reticulations are concolorous with the ground.

*Hab.* Chiguinda.

This insect closely resembles *Lycidola retifera* above described.

*Themistonoë humeralis*, n. sp.

Nigra; capite fulvo-flavo, macula verticis strigaeque pone oculos nigris; thorace fulvo-flavo, vittis tribus latis nigris; elytris ad apicem sat ampliatis, ad latera deflexis, macula humerali fasciaque lata post medium fulvo-flavis; coxis, femoribus quatuor antice pectoreque fulvo-flavis.

Long. 9 lin., lat. elytr. 4 lin.

First joint of the antennæ thick and cylindrical, the third joint twice as long as the first, thick, clothed with dense black pile; the following joints short, not quite black. Head and thorax rusty yellow, with a spot on the vertex of the head and a broad stripe behind each eye black; these black marks are continued on the thorax. The thorax is subcylindrical, slightly constricted before and behind the middle, with some strong punctures on each side of the mesial black stripe and along the base. Elytra with prominent angular shoulders, gradually and moderately dilated towards the apex, where they are two thirds broader than at their base, flat on the back (except at the apex), strongly deflexed at the sides (almost perpendicularly so near the base), strongly and closely punctured at the base, more finely posteriorly; the humeral keel is very strong, there is also a strong costa on the expanded portion, arising at shoulder and extending to the apex; there is a rusty yellow stripe on the shoulder, turned posteriorly towards (but not reaching) the suture; there is also a thin rusty yellow stripe on the margin below the shoulder, and a broad band behind the middle, which is dentate on both its margins; the apex of each elytron is completely rounded. The middle of the sterna and the middle of the basal portion of the abdomen are dirty yellow. ♀.

*Hab.* Sarayacu.

A second specimen ( $\sigma$ ), with precisely the same coloration, differs from the type in having the third joint of the antennæ less densely fringed, and the joints following it are more elongate; in the type the third joint nearly equals all the following joints taken together; whereas in the second example the third joint only equals the three following joints together. The scutellar region of the elytra is less strongly punctured. These are probably sexes of the same species.

*Themistonoë delectabilis*, n. sp.

This species is extremely close to *T. humeralis*; but I think the difference of colour &c. indicates more than a variety. It differs in having the yellow of a more ochreous colour; the elytra entirely of this colour, except a mark in the middle in the form of an inverted T, which (as well as the apical third of the elytra) is deep violet. The apical violet portion has a number of irregular oblique ridges which are not visible in *T. humeralis*. The underside of the insect is black, except the middle of the prosternum and the coxæ, which are dusky yellow.

*Hab.* Bogota (*H. Chesterton*).

XXIX.—*On two new Species of the Genus Paratymolus, Miers (Crustacea Brachyura), from Australia.* By WILLIAM A. HASWELL, M.A., B.Sc., Curator of the Queensland Museum, Brisbane.

[Plate XVI.]

UNDER the name of *Paratymolus pubescens*, Mr. E. J. Miers has recently described (P.Z.S. 1879, p. 45, pl. ii. fig. 6) a curious new podophthalmous crustacean from Japan, which he refers, though with some doubt, to the family Homolidæ. *Paratymolus* differs from *Homola* (1) in not having the last pair of legs elevated on the back, (2) in the possession of distinct cavities excavated under the front for the lodgment of the antennules, (3) in having the external maxillipedes operculiform. It approximates in some of its characters to the Corystidæ; and probably its nearest ally is *Telmessus* of White, together with which genus it might be regarded as forming a distinct family, having affinities, on the one hand, with the Homolidæ, and on the other with the Corystidæ.

During a recent dredging-excursion I obtained at Port

Denison, in Queensland, two species which are referable to this remarkable genus; and one of these I have since observed in Port Jackson. One of them is a very near ally of the Japanese species described by Mr. Miers; the other is rather widely separated from it, but shows sufficient agreement in essential characters to justify its inclusion in the same genus.

*Paratymolus bituberculatus*, sp. nov.

(Pl. XVI. figs. 1, 2.)

Carapace and limbs covered with a close pubescence. Rostral spines short, blunt; a short spine or tooth above the eye, and two others on the lateral border behind it, the hindermost the largest and placed at the angle of junction of the antero-lateral and postero-lateral borders; a small conical tooth situated about the middle of the postero-lateral border; gastric region with two prominent conical tubercles. Arm with four small teeth on its posterior border; wrist armed with a long slender spine; hand subtriangular, the upper border produced into a prominent tooth above the insertion of the dactylos, outer surface ornamented with two fasciculi of short stiff setæ. Ambulatory legs slender, terminal joint longer than the penultimate. Length of carapace 2 lines, breadth 2 lines.

*Hab.* Gloucester Passage, Port Denison, about 5 fathoms.

*Paratymolus latipes*, sp. nov.

(Pl. XVI. figs. 3-5.)

Carapace and limbs closely pubescent. Rostrum of two broadish lobes, each armed externally with a short acute spine directed forwards and slightly inwards; antero-lateral border with four acute spines, the first (the shortest) placed in front of the eye, the second behind it, and the third (the longest) about halfway between the second and the fourth, which occupies the lateral angle; dorsal surface smooth. Anterior limbs stout; arm provided with a few small slender spines on its internal and inferior borders; wrist armed at its internal and distal angle with a short stout spine; hand compressed, its outer surface ornamented with numerous granulations and a few minute spinules, upper border with a row of minute spinules, inner surface smooth. Ambulatory limbs laterally compressed, last joint longer than the penultimate. Length and breadth of carapace 4 lines.

*Hab.* Port Denison, Queensland; Port Jackson.

The Port-Jackson specimen has the carapace rather more convex than that from Port Denison, and the first pair of limbs

smaller ; but the differences are scarcely sufficient to necessitate the bestowal of a separate specific name.

#### EXPLANATION OF PLATE XVI.

- Fig. 1.* *Paratymolus bituberculatus*, magnified about 4 diameters.  
*Fig. 2.* First pair of legs of the same, magnified 7 diameters.  
*Fig. 3.* *Paratymolus latipes*, magnified 4 diameters.  
*Fig. 4.* Abdomen of the same.  
*Fig. 5.* Under view of the anterior portion of the body of the same, magnified 8 diameters.

XXX.—*On a Collection of Crustacea from the Malaysian Region*.—Part II. Telphusidea, *Catometopa*, and *Oxystomata*. By EDWARD J. MIERS, F.L.S., F.Z.S.

[Plate XIV.]

[Continued from p. 239.]

#### TELPHUSIDEA.

##### *Telphusa Larnaudii*, A. M.-Edwards.

Indo-Malayan seas. A male is in the collection without special indication of locality. Both this form and *T. denticulata* are so nearly allied to *T. fluviatilis* that I think it is probable that the examination of a sufficiently large series of specimens would show their identity.

*Telphusa sumatrensis*, sp. n.  
 (Pl. XIV. figs. 1, 2).

Carapace broader than long, rather convex in its anterior portion, and nearly smooth. Front more than one third the greatest width of the carapace, with the anterior margin straight ; its upper surface is punctulated, but not granulated or rugose. Some faintly indicated rugosities are visible on the carapace toward the epibranchial tooth, which is very small—scarcely distinguishable from the granulated line which defines the antero-lateral margins. The postfrontal crest is nearly obsolete, but, although scarcely distinguishable, is interrupted and divided into two median and two lateral portions, nearly as in *T. Larnaudii*. The chelipedes are smooth, not granulated or rugose, but slightly punctulated ; the carpus is armed with two spines on its inner margin, of which the anterior is the largest ; the fingers of the larger hand (in the male) are slightly arcuated, leaving an hiatus

when closed, and minutely toothed. Ambulatory legs and male postabdomen as in *T. Larnaudii*. Length of largest male 7 lines, breadth 9 lines.

W. Sumatra, Agam (two males and two females).

This species differs from *T. Larnaudii* in the not granulated or rugose carapace and chelipedes and the obsolescence of the postfrontal ridge and lateral epibranchial tooth. If it should prove to be merely a young state, it would throw doubt on the distinctness not only of *T. Larnaudii*, but of several other species of this very difficult genus. *T. philippina*, v. Martens, differs in possessing an epibranchial tooth and in the form of the postabdomen of the male; *T. picta* of the same author, in the form of the spines on the inner margin of the wrist and the denticulation of the fingers.

*Telphusa sinuatifrons*, M.-Edwards?

Carapace very much flattened, much wider at the branchial regions than in its posterior portion, transversely rugose near the antero-lateral margins; lateral epibranchial tooth distinct but not very prominent, the extraorbital angle or tooth not at all prominent and not projecting beyond the level of the front, which is not at all deflexed, about two fifths the greatest breadth of the carapace, with a very slight median and two lateral sinuses in its anterior margin. The postfrontal ridge is interrupted, the two median portions being more advanced than the lateral, which are continued in a nearly straight line to the epibranchial tooth. Length of carapace 1 inch 3 lines, breadth 1 inch 7 lines.

W. Borneo (an adult female).

The anterior legs are unfortunately wanting. Although this species resembles M.-Edwards's figure of *T. sinuatifrons* in the sinuated anterior margin of its front, a character peculiar to that species, the front appears to be relatively broader and the postfrontal line straighter; so that it may after all prove to be distinct.

Besides the foregoing there are two specimens (male and female) of a species belonging to that section of the genus which Stimpson designated *Geotelphusa*, which, on account of their mutilated condition, and the difficulty of determining the specific characters of the species of this section without large series for comparison, I will not designate by a distinct name. The carapace is considerably broader than long, and much inflated over the branchial regions; the postfrontal crest is indicated only by two well-marked prominences on either side of the middle line. The extraorbital angle is much depressed, so that there is no extraorbital tooth; the

epibranchial tooth is very small; and the antero-lateral margins of the carapace are defined by a distinct line. The front is less than one third the greatest width of the carapace; and its anterior margin is marked with a shallow median sinus. One (probably the larger) chelipede is absent in each specimen; the remaining one is slender; the carpus is armed with two strong spines, of which the anterior is the larger, on its inner margin; hand nearly smooth; fingers slender, straight, and minutely denticulated. Postabdomen of male somewhat constricted in the middle; the terminal joint longer than broad.

This species is apparently allied to *T. picta*, v. Martens, but differs in the spines of the wrist and probably in the form of the postabdomen of the male. No locality was preserved with the specimens.

*Paratelson tridentata*.

*Paratelson tridentata*, M.-Edwards, Ann. Sci. Nat. (sér. 3) Zool. xx. p. 213 (1853); Arch. Mus. Hist. Nat. vii. p. 171, pl. xiii. fig. 1 (1854); De Man, Notes from Leyden Museum, no. xix. p. 62 (1879).

Bali (an adult female); Java (a young male with *P. convexa*). An adult male and female are in the collection without definite locality.

This species, as Mr. de Man has pointed out, may always be distinguished by the form of the posterior epibranchial tooth and the absence of spines on the meropodal joints of the legs.

*Paratelson convexa*.

*Paratelson convexa*, De Haan (ined.), De Man, Notes from Leyden Museum, no. xix. p. 63 (1879).

Java (six specimens, including males, females, and young). In three of these specimens the body and legs are spotted or variegated with dark red. Nias (an adult female); Borneo (a young female).

In the young individuals the angular excavation of the inferior wall of the orbit is less marked than in the adult; and I think it possible that the examination of a sufficiently large series might show that *P. maculata* is not specifically distinct.

CATOMETOPA vel GRAPSOIDEA.

*Macrophthalmus carinimanus*, M.-Edw.

A male and female, of which the exact locality has not been preserved, are in the Museum collection, which agree



very well with Milne-Edwards's short diagnosis of this species. The eyes, in these specimens, do not reach quite to the antero-lateral angles of the carapace. The arm of the anterior legs has one or two spinules at the distal end of its inner margin; the wrist has a spinule on its inner surface; the hand is slender, granulated on its upper, and slightly on its outer surface; the lower finger is bent downward, so as to form a distinct angle with the inferior margin of the hand; the upper finger (when closed) meets the lower at its apex only; and the two enclose a large triangular space. The inner margin of the hand and arm is clothed with dense hair.

Specimens in the British-Museum collection from Singapore, the Mauritius, Penang, and Australia, which have been referred to *M. carinimanus*, belong to the following species.

*Macrophthalmus convexus*.

*Macrophthalmus convexus*, Stm. Proc. Ac. Nat. Sci. Phil. p. 97 (1858).

The specimen I refer to this species belongs to Milne-Edwards's second section, having the carapace less than twice as broad as long, and the inner surface of the hand unarmed. The carapace is coarsely granulated on the sides; and the branchial regions are sometimes armed with two small granulated prominences, with the antero-lateral angles spiniform and prominent; posterior to these, on the lateral margins, is a second tooth; the front is spatulate; the eye-peduncles do not quite reach to the end of the antero-lateral teeth; the anterior legs (in the male) have the inner margins of the arm and wrist granulated, the hand rounded and finely granulated on its upper margin, with a longitudinal granulated line (not a ridge) on its outer surface close to the lower margin; the lower (immobile) finger is deflexed, but does not form so decided an angle with the lower margin of the hand as in the preceding species; the distal end of the palm and the fingers are hairy on their inner surface; the fingers (when closed) include a much narrower space than in *M. carinimanus*; the ambulatory legs are smooth, not pectinated, scantily fringed with hair, and with a very small spine (which is sometimes obsolete) near the distal end of the upper margin of the merus. Length 7 lines, breadth at second marginal tooth 13 lines.

Indo-Malayan seas (a male).

This species is evidently allied to *M. simplicipes* and *M. affinis*, Guérin, from Bombay, which, however, are represented as having two teeth behind the antero-lateral or extra-

orbital tooth. *M. setosus*, M.-Edw., and *M. japonicus*, De Haan, have the antero-lateral angles much less prominent and acute. *M. inermis*, A. M.-Edwards, which may be identical with this species, is represented as having the upper margin of the hands sharp-edged, not rounded.

*Ocypode ceratophthalma* (Pallas).

Celebes, Macassar (an adult male); Batjan (an adult male).

*Ocypode cordimana* (Latr.).

Celebes, Macassar (a female).

GELASIMUS.

There can be little doubt that many of the numerous species of this large and difficult group have been founded on insufficient characters, and will be reduced to synonyma whenever the comparison of sufficiently large series of specimens of different ages and sexes shall have demonstrated the variability of the denticulation of the inner margins of the fingers of the larger chelipede and of other characters that have been employed in distinguishing the species.

\* *Front narrow between the eyes.*

*Gelasimus vocans* (Linn.).

Three males are in the collection, without definite indication of locality. There is a strong triangular tooth near the distal end of the upper margin of the arm in this species; the hand is strongly granulated externally, and has two very strong granulated ridges on its inner surface; the fingers are robust and laterally compressed; there is always a strong triangular lobe or tooth near the distal extremity of the lower finger, and usually, but not invariably, a second between this and the base.

*Gelasimus Marionis*.

*Gelasimus Marionis*, Desm. Consid. Crust. p. 124, pl. xiii. fig. 1 (1825); M.-Edw. Ann. Sci. Nat. (sér. 3) Zool. xviii. p. 145, pl. iii. fig. 5 (1852); Hoffmann in Recherches faune Madagascar, Cr. p. 15, pl. iii. figs. 16-18 (1874); nec M.-Edw. Hist. Nat. Crust. ii. p. 53 (1837). *Gelasimus cultrimanus*, White, P. Z. S. p. 84 (1847); Adams and White, Zool. Samarang, Cr. p. 49 (1848); M.-Edw. Ann. Sci. Nat. l. c. p. 145 (1852).

Batjan (two males).

The principal character that distinguishes this species from *G. vocans* is the absence of prominent lobes on the lower im-

mobile finger; and I regard it as very probable that it is merely a variety of that species. There is, as in *G. vocans*, a strong triangular tooth at the distal end of the upper margin of the arm; the palm is strongly granulated in the middle of its outer surface, and there is a well-marked concavity on the outer surface at base of the lower finger in both forms.

The relative length of the fingers as compared with that of the palm is clearly a character that varies with the age of the individual, the fingers being always shortest in the smallest examples. The upper finger is never longitudinally sulcated, either in *G. vocans* or *G. Marionis*.

*Gelasimus arcuatus*.

*Gelasimus arcuatus*, De Haan, Faun. Japon. Crust. pp. 53, 261, pl. vii. fig. 2 (1835).

*Gelasimus tenuimanus*, White, List Crust. Brit. Mus. p. 35 (1847), sine descr.

Borneo (an adult male).

In what I regard as the typical condition of this species, the fingers of the larger hand are greatly elongated and without prominent lobes on their inner margins. They are often nearly three times the length of the hand.

*Gelasimus arcuatus*, var. *forcipatus*.

*Gelasimus forcipatus*, Ad. & White, Zool. Samarang, Crust. p. 50 (1848); M.-Edw. Ann. Sci. Nat. (sér. 3) Zool. xviii. p. 147 (1852).

? *Gelasimus brevipes*, M.-Edw. l. c. p. 146, pl. iii. fig. 7 (1852).

? *Gelasimus rubripes*, M.-Edw. l. c. p. 148 (1852); Jacq. & Lucas, Voy. Pôle Sud, Zool. iii. Cr. p. 66, pl. vi. fig. 2 (1853).

Batjan (seven males, of different sizes).

In all the specimens I refer to this variety the fingers are shorter, not exceeding twice the length of the palm, and nearly always lobed or toothed on their inner margins. In the smaller examples the length of the fingers is relatively less; and in the smallest they are not half the length of the palm.

In the largest of the specimens from Batjan there is (besides the granulations with which the inner margins of the fingers are always armed) a single tooth on the lower finger; in three others, one on the upper and none on the lower; in two others, two on the upper and one on the lower; while in the smallest the teeth are obsolete. The width of the merus of the ambulatory legs also appears to vary somewhat in this species.

*G. arcuatus* may always be distinguished from *G. vocans* by the absence of the strong triangular tooth at the distal end of the arm, its place being taken by a series of granules; the

hand, moreover, is very coarsely granulated on the whole of its outer surface, and is of a reddish tinge in its lower half, which is not so markedly concave as in *G. vocans*; and the upper finger is sulcated on its outer surface.

**\*\* Front broad between the eyes.**

*Gelasimus annulipes*, M.-Edw.

A male from Batjan and two specimens without definite locality are in the collection. Although the denticulations of the fingers vary considerably in this species, there is nearly always a strong triangular subterminal tooth on the lower immobile finger.

Three small examples of a *Gelasimus* allied to the above are in the collection (one from Batjan), which I will not venture to designate by a distinct specific name. The lateral margins of the carapace converge more rapidly to the posterior margin; and the antero-lateral angles are more produced and acute. The larger chelipede is nearly smooth externally, as in *G. annulipes*; but the upper finger is slenderer toward its distal end, and the lower finger (although denticulated on its inner margin) is without a subterminal tooth. In two of the specimens there is no granulated ridge on the inner surface of the hand near the base of the fingers; in the third specimen this ridge is present; the prominent granulated ridge on the inner surface of the palm, near its infero-proximal angle, is equally developed in all of the specimens. Whether this be the variety designated *alhimana* by Kossmann, who founded his description on specimens from the Red Sea, could scarcely be decided without comparison of the types.

*Grapsus pictus* (Latr.).

Amboina (an adult female).

A very constant character distinguishing this species from *G. strigosus* is to be found in the form of the front, which is relatively narrow, with the anterior margin arcuated, in *G. pictus*, whereas in *G. strigosus* it is broader with the anterior margin straight.

*Varuna litterata* (Fabr.).

Bali (two males).

*Pseudograpsus penicilliger* (Latr.).

Batjan (two adult males in fine condition).

The genus *Heterograpsus* of Lucas is so very nearly allied

to *Pseudograpsus* in all structural characters, that I do not know whether it can be maintained as distinct. *Pseudograpsus penicilliger* is merely a more robust, thicker *Heterograpsus* with greatly developed chelipedes.

There are also three adult males of this species from the New Hebrides (Aneiteum) in the Museum collection.

I refer here with doubt a female in mutilated condition in the collection of Dr. Bleeker from Celebes (Macassar).

It resembles the male *P. penicilliger* in all particulars except that the carpus of the anterior leg is armed with a distinct lobe or tooth on its inner margin, and the outer surface of the penultimate joint, which is somewhat rugose, is marked with a longitudinal raised line, which is continued along the outer surface of the lower finger. Further material is needed to show whether these characters are sexual or indicative of a distinct species. As is usual in the females of some allied forms, the chelipedes are entirely devoid of hair. If distinct, this form may be designated *Pseudograpsus dentatus*.

### *Ptychognathus pilipes*?

? *Gnathograpsus pilipes*, A. M.-Edw. Nouv. Arch. Mus. Hist. Nat. iv. p. 184, pl. xxvii. figs. 6-10 (1868).

I refer to this species with some hesitation a small female example from Batjan. It agrees very well with males and females in the Museum collection from the Philippines (Guimaras). The close affinity of *Gnathograpsus* to *Ptychognathus* was recognized by Prof. A. Milne-Edwards; and I can see no sufficient reason for regarding them as distinct genera. It is worthy of note that neither A. Milne-Edwards, Stimpson, nor Man have noted the common occurrence in the females of this genus of a small tuft or patch of hair near the distal end of the lower (immobile) finger of the chelipedes. This hairy patch exists in the females I refer to *P. pilipes*. It is possible that none of the authors above cited had females before them.

### *Metopograpsus messor* (Forskål), var. *frontalis*, nov.

Celebes, Macassar. An adult male.

In its coloration this example appears to approach very near to what may be regarded as the typical form of the species, represented by specimens from the Red Sea in the Museum collection.

The front is relatively wider than in most of the specimens of this species in the Museum collection—about three and a

half times the length of the upper orbital margin; and its anterior margin is straight, not at all sinuated in the middle. I have observed, however, some variation in the width of the front in this species.

There is a second male, without definite locality, in the collection, that agrees in every particular with the Celebes example, except that on one side of the carapace there is a distinct tooth behind the extraorbital tooth, and on the other side an indication of a similar tooth, the margin of the carapace being slightly sinuated. This variety appears to mark a transition to *Metopograpsus quadridentatus*, Stimpson, and *M. oceanicus*.

From *M. latifrons*, White, this variety is distinguished by the much less coarsely denticulated front and less accentuated frontal lobes.

#### SESARMA.

- \* *Lateral margins of the carapace without any tooth behind the extraorbital tooth.*

##### *Sesarma affinis*, De Haan.

Two specimens (males) are in the collection, without special indication of locality. They agree with De Haan's figure in having two minutely pectinated oblique ridges on the upper surface of the hand, a character which, curiously enough, is mentioned neither by De Haan nor by Mr. de Man in his remarks upon this species (Notes Leyden Museum, ii. (v.) p. 22, 1879). The tubercles of the upper mobile finger are somewhat more numerous than in De Haan's type.

*Sesarma aspera* of Heller, from Ceylon, Madras, and the Nicobars, is either identical with or very nearly allied to this species; the sides of the carapace, however, are represented as nearly parallel, not convergent distally.

##### *Sesarma granosimana*, sp. n. (Pl. XIV. fig. 3.)

Carapace nearly quadrate, with the surface punctulated, but not granulated or rugose; antero-lateral margins without any tooth except the extraorbital tooth. The anterior margin of the carapace is divided into four nearly equal and not very prominent lobes; the front, although nearly vertically deflexed, does not form a marked angle with the anterior margin of the carapace; it is about two thirds the width of the carapace; and its anterior margin is nearly straight, but slightly reflexed on each side of the middle line. The anterior legs (in the male) are short; the arm has a very small tooth at

the distal end of its upper margin; the whole of the outer surface of the wrist is covered with short transverse ridges, which pass into the form of granules on the outer surface of the palm; on the inner surface of the wrist is a spiniform tooth; there are no pectinated crests on the upper surface of the palm; the mobile finger is granulated above at base, and both fingers are denticulated on their inner margins. The merus of the ambulatory legs is considerably dilated, and armed with a small spine near the distal end of its upper margin; the two following joints are marked with longitudinal raised lines; the dactyli are slender. The post-abdomen of the male is rather broad; its terminal joint considerably narrower than the penultimate joint. Length 7 lines, breadth 8 lines.

Indo-Malayan seas (no definite locality). A male and female are in the collection.

*S. granosimana* is nearly allied to *S. Dehaanii*, M.-Edw., but is distinguished by the existence of a tooth on the inner margin of the wrist, the more dilated merus of the ambulatory legs, &c. The legs, in the two specimens I have examined, are not clothed with long hairs as in *S. Dehaanii*.

*S. trapezium*, Dana, which is also apparently allied to this species, is described as having the carapace much narrowed behind, the abdomen of the male narrow, and as having a dense patch of hair near the base of the mobile finger\*.

\*\* *Carapace with a second (epibranchial) tooth behind the extraorbital tooth.*

*Sesarma bidens* (De Haan).

Indo-Malayan seas (one adult male without definite locality).

*Sesarma tæniolata*, White (ined.), Miers.

Borneo (an adult male). In this specimen and in the others in the Museum there exist but few traces of the tufts of hair with which, according to Mr. de Man (Notes Leyden Museum, ii. (v.) p. 26), the carapace is usually covered.

*Sesarma Bocourti*, A. M.-Edwards.

Borneo (two males and a female). The males agree very well with the diagnosis of A. M.-Edwards, and the longer

\* I have not been able to compare *S. granosimana* with the description of *Sesarma chirogona*, Targioni-Tozzetti, "Crostei Brachiuri ed Anomuri," in 'Zoologia della R. pirosorvetta Magenta,' Firenze, 1877, 8vo, as I have not yet had an opportunity of consulting this important work.

and more detailed description of Mr. de Man (*l. c.* p. 28). In the female (which has not as yet been observed) the hand is slender, not dilated and compressed as in the male, and its external surface, although flattened, is less coarsely granulated towards the fingers, which are nearly smooth.

*Sesarma intermedia* (De Haan).

Indo-Malayan seas (a male and female without definite locality).

*Metagrapsus punctatus*, A. M.-Edw.

Indo-Malayan seas (two males).

*Leiolophus abbreviatus* (Dana).

Indo-Malayan seas (one male).

*Pinnotheres obesus*, Dana? (Pl. XIV. fig. 4.)

? *Pinnothera obesa*, Dana, Cr. U.S. Expl. Exp. xiii. p. 380, pl. xxiv. fig. 3 (1852).

I thus designate three specimens of a *Pinnotheres* without locality in the collection. The carapace is subglobose, with the antero-lateral margins regularly rounded and entire, and is nearly naked; the front is very small, and projects slightly; its anterior margin is rounded or subtruncated. The merus of the outer maxillipedes is but little longer than broad, regularly rounded at its distal end (where it is most dilated); its outer margin also is arcuated, and its inner margin straight; its surface near the inner margin is somewhat thinly setose; the antepenultimate and penultimate joints are robust; the latter is fringed with hairs along its outer margin and at its distal end, which is obliquely subtruncated; the slender dactylus is articulated with the penultimate joint at a little before the middle of its inner margin, and does not project beyond its apex. The anterior legs are small and smooth, and present nothing remarkable; the ambulatory legs also are very slender and naked.

All the specimens are females.

This species, in the form of the broadly dilated merus of the outer maxillipedes, appears to differ from all the species figured by Milne-Edwards in his revision of the group in 1853, and others since described. A specimen from Borneo is in the Museum collection. A figure is given of the outer maxillipede, because it is not quite of the form figured by Dana; but I do not think the difference is sufficient to warrant the specific separation of the two forms.



OXYSTOMATA *vel* LEUCOSOIDEA.*Camara calappa* (Linn.).

New Guinea (an adult female); Aroe Islands (an adult female).

*Calappa lophos* (Fabr.).

Celebes, Macassar (a male).

No trace of the characteristic coloration exists in this specimen. The carapace is somewhat more tuberculated, and the denticulation of the antero-lateral margins near the extra-orbital tooth is less marked than in a specimen in the Museum collection from the Indian Ocean, which I refer to the typical *C. lophos*. It is possible that these characters indicate the existence of distinct varieties or species.

*Matuta victrix*, Fabr.

Celebes, Macassar (two males and a female); Bali (an adult female). A female from Batjan also perhaps belongs to this species, in which all trace of the spots or markings have disappeared.

*Matuta circulifera*, sp. n. (Pl. XIV. fig. 5.)

Carapace everywhere rather finely granulated; the granulations rather coarser on the more elevated parts; the tubercles all distinct, but not very prominent. The rostrum is small, obtuse, and subentire, with only a very obscure indication of a median notch. Lateral marginal spine long, acute, and straight. Hand of male nearly as in *M. lunaris* (*M. rubro-lineata*, Miers) and *M. lineifera*. Lines of the carapace forming complete and distinct circles, arranged in three transverse series, *i. e.* a transverse series of three circles on the anterior portion, of four on the median portion, and of three on the posterior portion of the carapace.

Indo-Malayan seas. An adult male is in the collection of this interesting form, which belongs to section A of the genus, and is distinguished from both *M. lunaris* and *M. lineifera* by the strikingly symmetrical coloration and the form of the front.

The coloration has unfortunately much faded in the unique example (preserved in spirit), and, it is to be feared, will soon altogether disappear.

*Matuta Banksii*, Leach.

Celebes (a male); Amboina (a female); New Guinea (an adult male); Bali (a female).

In a fine adult male without locality the granulations of the carapace are somewhat less distinct.

*Matuta obtusifrons*, Miers.

Bali (a female).

This species is easily distinguished by the strongly-marked tubercles and obtuse front from *M. laevidactyla*\*.

*Leucosia pallida*, var. *obscura*.

*Leucosia obscura*, Bell, Trans. Linn. Soc. xxi. p. 285, pl. xxx. fig. 3 (1855).

? *Leucosia moresbiensis*, Haswell, Proc. Linn. Soc. New S. Wales, iv. p. 49 (1879), var.

Indo-Malayan seas (two females without definite locality).

Mr. Haswell, in his excellent description of *L. moresbiensis*, acknowledges its affinity to *L. obscura*. This description, moreover, agrees better than that of Bell with the specimens designated *L. obscura* in the Museum collection. In these specimens there is a distinct row of granules on the inner margin of the hand, and the granulation of the posterior and postero-lateral margins of the carapace and the armature of the fingers are precisely those of *L. moresbiensis*. The only difference that I note is that in *L. obscura* (and *L. pallida*) there are four, not three, large tubercles on the lower margin of the thoracic sinus; but this alone would probably not suffice to distinguish *L. obscura* from *L. moresbiensis*. It is certain, therefore, either that Bell's description and figure are inaccurate, or were based on specimens belonging to a distinct species from the examples labelled *L. obscura* in the Museum collection.

*Leucosia pallida*, Bell, in all structural characteristics is identical with *L. obscura*; it differs only in the lighter coloration, which may possibly be due to the bleaching of the specimens. Among the specimens in the Museum collection are some on which the granulation of the inner margin of the hands is obsolete.

*Myra carinata*, Bell.

Celebes, Macassar (a male).

\* I propose this name for the specimens that I, in my revision of the genus, referred to *M. lunaris* (Herbst). Hilgendorf, who had before him Herbst's typical example, has shown (Monatsb. Ak. Berlin, p. 810, 1878) that the species designated *M. rubrolineata* is really the *lunaris* of Herbst; consequently the specimens I referred to *lunaris* must receive a new appellation. It was impossible, in the case of such nearly allied species, to say, from the figure and description alone, what species Herbst had designated *lunaris*.

It appears to me not improbable that the comparative examination of a sufficient series of specimens would demonstrate that this species and *M. elegans* are founded on half-grown specimens.

*Iphis septemspinosa* (Fabricius).

Celebes, Macassar (a female).

*Arcania novemspinosa* (White), var. *aspera*, n.

A specimen (adult female) without definite locality differs from White's type of *novemspinosa* in the British Museum in the broader and much more closely granulated carapace, and the relatively shorter spines of the posterior and posterolateral margins. White's specimen is a male. Although the characters distinguishing the genera *Iphis* and *Arcania* are scarcely of generic value, it may be convenient to retain the former name for the Fabrician *septemspinosa*, to which it has long been applied, and which differs somewhat more markedly from the species of *Arcania* than these do among themselves.

*Dorippe sima*, M.-Edw.

Borneo (an adult female).

[To be continued.]

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XXXI.—*On Hypochlorin and the Conditions of its Production in the Plant.* By Prof. PRINGSHEIM\*.

IN a previous communication† I called attention to the existence in green vegetable cells of a body to which I gave the name of "hypochlorin," on account of its close relationship to chlorophyll. I now give some more detailed statements as to its occurrence and microchemical characters, and append thereto some further remarks upon the constitution of the chlorophyll-bodies.

So far as they regard hypochlorin, these statements relate essentially to the behaviour of this body at high temperatures and to the conditions of its production in the seedling plant. With regard to the chlorophyll-bodies, they will at the same

\* Translated by W. S. Dallas, F.L.S., from the 'Monatsbericht der Akademie der Wissenschaften zu Berlin,' November 1879, p. 860.

† Monatsb. Berl. Akad. July 1879; translated in this Journal for January 1880.

time indicate a noteworthy structure of those bodies which has hitherto not been noticed by anatomists, and demonstrate the wide diffusion of fatty oil in them.

### I. *Structure and Composition of the Chlorophyll-bodies.*

In the direct observation of the fresh plant the hypochlorin cannot be distinguished in the apparently homogeneous chlorophyll-bodies; for it is only in rare instances that traces of its presence can be detected in them under normal conditions. Its presence betrays itself at once, however, when the green cells are treated with hydrochloric acid.

Under the influence of this acid, as I have already briefly stated in my former memoir, dark, deep-reddish-brown or rust-coloured, irregularly bounded forms are separated in a few hours in the chlorophyll-bodies, especially at their periphery, and also between neighbouring chlorophyll-bodies. These are not perfectly spherical drops, but rather semifluid masses of irregular form, with sometimes spherical, sometimes plane limiting surfaces, which sometimes push forth angular or pointed processes, and thus become indistinct crystalline scales or nests. From these, after a longer or shorter time, shoot forth long, pointed, straight or curved needles, and extremely thin twisted filaments, or even shorter and thicker rods.

These extremely remarkable effects, which occur without exception in all chlorophyll-plants after treatment with hydrochloric acid, constitute a characteristic and infallible reaction for hypochlorin. Without any further examination, they demonstrate directly by their external appearance the presence of a hitherto unnoticed substance in the chlorophyll-bodies of plants. But the circumstances under which they occur present many difficulties in the way of the right conception of the relation here brought to light, and therefore require a more thoroughgoing examination and investigation.

As has already been stated, even direct observation leaves no doubt that the substance which afterwards (perhaps modified by the process of its production) becomes converted into the crystalline needles outside the chlorophyll-bodies was previously present in their fundamental substance. It is evidently drops of an oleaginous consistency which first separate from the fundamental substance, gradually increase or coalesce into larger masses, and form the foundation of the future needles and filaments. No distinct structure is recognizable in these needles and filaments; and one may often be in doubt, when the formations are thicker and shorter, whether they possess an organic structure or a crystalline texture.

Of all known histological formations they remind us most (and, again, especially the thicker and twisted forms) of the bacillar forms of many so-called wax coatings of leaves, which, as is well known, consist of diverse mixtures of substances poor in oxygen. And as from their conditions of occurrence and solubility they are evidently organic formations which appear to belong to a group of proximate constituents of the plant allied to these wax bacilli, and also visibly proceed from a common oleaginous parent substance, one may easily suppose that they consist of a mixture of resin and essential oil, such as occurs not unfrequently in vegetable tissues. The consistency, the limitation, the solubility, and difficult mobility of the separating drops more nearly resemble essential than fatty oils.

By the absence of the pure drop-form, and still more by the directly recognizable processes of conversion of the surface into multifarious structures of indistinctly crystalline texture, these imperfectly fluid products of separation produce of themselves the impression of a mixture of solid and fluid substances, or rather of a kind of mother liquor of a separating solid compound, whilst, at the same time, they give rise to the idea of an essential oil in process of resinization. Further, this microscopical character agrees with the behaviour to all known solvents of resins and oils.

All the forms under which these segregations make their appearance, the irregularly limited drops, the crystalline scales, needles, filaments, &c., are insoluble in water, in saline solutions, and in dilute mineral and organic acids; but they dissolve readily and completely in ether, benzole, sulphide of carbon, and essential oils, and also in absolute or even in moderately dilute alcohol, although frequently only after a considerable time, and with more or less difficulty.

The constituents of which this hypochlorin mixture consists have not previously been distinguished in the fundamental substance of the chlorophyll-bodies, with the exception of the colouring-matter which they contain. Nothing especially has ever yet been known of a body with the properties of hypochlorin and its peculiar forms. The deep coloration, however, of the drops and needles might lead many to suspect (as I have found during the demonstration of these formations) that the separated drops in their whole mass consist only of the colouring-matter of the chlorophyll, which, being separated from the fundamental substance by the hydrochloric acid, becomes solidified or crystallizes in the form of needles and filaments.

But this is not the case. That the colour of the separated

masses is due to the colouring-matter of the chlorophyll is undoubtedly correct: but this colouring-matter does not form any fluid of itself; and as it is insoluble in dilute and even in concentrated hydrochloric acid, as is shown by direct observation if we treat the chlorophyll-bodies in the unopened cell with hydrochloric acid, a special menstruum must exist in the separated masses, which serves as the bearer of the colouring-matter that tinges the drops and needles. This, indeed, becomes directly perceptible; for the needles, filaments, and rods often *lose their colour* when they have become older and been for a considerable time exposed to the light, completely retaining their form, however; and in many cases the rigid structures are *colourless even at their production*. Their colour is therefore due solely to a contamination with colouring-matter which has been carried over.

The drops separating under the action of hydrochloric acid consist, therefore, of an oleaginous fluid tinged with dissolved chlorophyll-colouring-matter, which is either itself crystallizable or contains a crystallizable substance, "hypochlorin;" and therefore, as will be seen from this statement, I understand under the name "hypochlorin" not the entire mixture of which the masses separable by hydrochloric acid from the chlorophyll-bodies consist (which, indeed, includes the colouring-matter tinging them), but only the body contained in them which afterwards solidifies in an indistinctly crystalline form, or (which is the same thing) the foundation of this crystallizable body originally present in the chlorophyll-grain. For it may still appear questionable whether the body which subsequently acquires a crystalline texture outside the chlorophyll-body was present with the same properties in the fundamental substance, or undergoes, during its passage out, a change which causes its solidification and crystallization.

Moreover, I will remark, we may regard the hypochlorin reaction, *i. e.* the formation of the dark secretions from the chlorophyll-bodies, as not a specific action of hydrochloric acid; for it is produced also by other agents.

Picronitric acid, for example, in various degrees of dilution, produces in most cases precisely the same effect as hydrochloric acid, but does not furnish such clear images, as it attacks the fundamental substance of the chlorophyll-bodies more strongly, by which means the forms become more indistinct.

In all preparations of green tissues which have lain for months or years in glycerine or chloride of calcium, the dark indefinitely bounded hypochlorin-masses also appear here

and there, separated spontaneously, as it were, from the chlorophyll-bodies.

It is therefore certain, even from our present experience, that the oleaginous substance which is a constituent of every chlorophyll-grain can be separated therefrom by various means. It would almost appear that this can be effected purely mechanically by displacement and disturbed adhesion.

One of the simplest means of separation is the application of moist heat. If green tissues be heated with water, or distilled with aqueous vapour, drops of an oleaginous substance separate from the fundamental substance of the chlorophyll-bodies. The phenomenon is analogous to that which Briosi produced in the chlorophyll-bodies of the *Musaceæ* by treatment with cold water. In his fine memoir on this subject \* he assumes (and in this later observers have followed him) that the normal occurrence of oil in the chlorophyll-bodies of the *Musaceæ* is an exceptional case, forming as it were a substitute for deficient starch. But, as I shall here show, the occurrence of oil in the chlorophyll-bodies of plants is quite a general phenomenon and certainly not directly dependent on the presence or absence of starch-enclosures; only, it would appear, the escape of the oil from the chlorophyll-bodies does not take place in most plants except by treatment with water of higher temperature.

In many plants a heat of 50° C. (=122° F.) suffices; and at this temperature any starch-enclosures that may be present do not swell up. Other plants require higher temperatures, when, in consequence of the swelling of the starch-enclosures or the bursting of the whole chlorophyll-grain, the comprehension of the process may be rendered more difficult by collateral circumstances. The phenomenon is also easily called forth if the tissues are exposed for from ten to fifteen minutes or longer to the vapours of boiling water.

In all cases there are, after this treatment, as already indicated, at the periphery of the chlorophyll-bodies, some smaller or larger oil-drops, which clearly have issued from the chlorophyll-bodies under the action of the warm water or of the hot vapour.

The chlorophyll-bodies themselves at the same time acquire the nature of hollow bodies, which may put on a different appearance in different plants according to the temperature employed and the duration of the action. They either constitute spongy porous masses, or form hollow trabecular networks, or, lastly (especially when strong swelling with

\* Bot. Zeitung, 1873, p. 529.

bursting of the whole grain has taken place), they consist only of the torn fragments of the envelope of the ruptured grain. All these solid residues are formed of the so-called protoplasmatic foundation of the chlorophyll-body and its inflated starch-enclosures, and are more or less strongly tinged with green by nearly unaltered chlorophyll-colouring-matter.

The oil-drops separated from these solid residues by the warm water or hot vapour, and escaped from the chlorophyll-bodies, *which always dissolve readily and completely in alcohol or ether*, are also tinged more or less with chlorophyll-colouring-matter, most of them in different tints of green and blue; but the darker ones even appear reddish brown, and then, leaving out of consideration the smaller size, produce the same external impression as the first-mentioned drops of the hypochlorin-mixture separated by hydrochloric acid. Nevertheless I do not think that they are identical with the latter. They are distinguished not only by the less degree and generally greater purity of their chlorophyll-green coloration, but also by their readier solubility in alcohol, and, lastly, by their more regular drop-like shape and especially by their permanence in heat. I therefore (as I may here state in anticipation) hold that these oil-drops represent a second non-volatile and uncrystallizable oil present in the chlorophyll-body, which exists in it side by side with the volatile and crystallizable hypochlorin, and in association with the latter forms those irregular masses which issue from the chlorophyll-bodies under the influence of hydrochloric acid.

My reasons for this opinion are as follows:—

It is, in the first place, exceedingly striking that the oil-drops extractible from the chlorophyll-bodies by heat are very much inferior in their mass to the masses of oleaginous substance which can be separated from the same chlorophyll-bodies by hydrochloric acid. Of those large, irregularly bounded, diversely pointed and angular masses which appear under the influence of hydrochloric acid, nothing is to be seen under the action of moist heat. The drops which issue in this case are smaller and more or less exactly spherical; and they do not solidify, but remain fluid. They contain none, or mere traces, of that crystallizable substance which, in the masses separated by hydrochloric acid, calls forth those singular changes of form which I have already described.

We cannot, however, assume that this substance is still present in the solid residues of the heated chlorophyll-bodies and was merely not separated by the action of heat; for by subsequent treatment with hydrochloric acid no further increased or fresh separation of oil can be effected. With



respect to the oil separated, hydrochloric acid calls forth no further change in the behaviour of the chlorophyll-bodies; and the great difference herein shown in the action of hydrochloric acid upon chlorophyll-bodies, according as the latter have or have not previously been heated, appears the more noteworthy, as the chlorophyll-colouring-matter in itself undergoes no essential alteration by heating, especially when the application of heat is of short duration and the temperatures are not high. For the modification that chlorophyll undergoes spectroscopically when heated in water appears to be chemically of no great consequence; so that, as is well known, for many reasons it might even be advisable, in order to render the solution of chlorophyll more persistent, to boil the green tissues with water before the extraction.

The fact remains established:—The remarkable reaction that hydrochloric acid produces in *unheated* chlorophyll-bodies does not occur in those *which have been heated*; and the cause of its non-occurrence cannot be sought in any alteration of the *colouring-matter*.

As the interruption of the hydrochloric-acid reaction for hypochlorin by previous heating of the tissues is fitted to give us a closer insight into the properties of that body, it may be here specially elucidated by a few examples.

If filaments of *Cladophora* in the fresh state are treated directly with hydrochloric acid, the larger hypochlorin-masses (already repeatedly described) make their appearance in every cell without exception. In strongly vegetating filaments with abundant cell-contents, the latter are, as it were, overcrowded with the masses formed by the hypochlorin-mixture. But if the filaments of *Cladophora* are previously heated only from five minutes to a quarter of an hour in water of 50° C. (=122° F.), under which treatment the cell-contents remain essentially unaltered in colour and form, and even appear more transparent than before, and starch-grains and amyllum-foci do not swell up, nothing of the hypochlorin-mixture is to be detected in them after the same treatment with hydrochloric acid. All those numerous larger drops, scales, &c. which the hydrochloric acid brings forth in the fresh are wanting in the heated filaments.

A similar behaviour is presented by filaments of *Ædogonium*, *Mesocarpus*, and *Spirogyra*, and, in general, in Algæ with so-called amorphous chlorophyll. In these a still shorter exposure to heat and a lower temperature will often suffice.

Even in the well-limited chlorophyll-bodies of the *Nitellæ* and *Charæ*, and many higher plants with delicate leaves, *e. g.*

in *Elodia*, *Callitriche*, &c., the heating of the whole plant in water of 50° C. for from a quarter to half an hour is sufficient for the complete suppression of the hypochlorin reaction. Other plants require that the action should be of longer duration or the temperature higher. A brief boiling of the tissue in water or treatment of the plant with the vapour of boiling water leads, however, to the same result in all of them.

After such treatment as has been stated, the hypochlorin reaction with hydrochloric acid no longer makes its appearance in the tissues, or at any rate not to the same extent as in the fresh tissues.

There is especially a regular absence of all those larger crystalline scales which the hypochlorin-mixture produces in the fresh plant under the influence of hydrochloric acid. In the tissues heated to a considerable temperature with water, or boiled, or subjected to distillation with water (even when they are subsequently treated with hydrochloric acid) there are now at the periphery of the chlorophyll-bodies only those few and isolated small oil-drops which, as I have already described, separate from the fundamental substance by the action of heat alone, and which, without undergoing any further alteration by hydrochloric acid, obstinately retain the fluid state even under a continued application of heat.

It consequently appears the simplest course to refer the interruption of the hypochlorin reaction by heat, and the non-appearance of the crystallizable segregations when the green tissues are merely heated, to the fact that the peculiar matter in the hypochlorin-mixture which causes its crystalline solidification is destroyed in the chlorophyll-bodies or dissolved by warm water, or becomes volatilized with the hot aqueous vapours.

The latter is my opinion. This microscopic behaviour of the chlorophyll-bodies when heated and the above conception are in agreement with certain attempts which, under the supposition that hypochlorin is a volatile substance, I have made with the view of preparing it on the large scale for chemical analysis, by the distillation of green tissues with superheated steam.

In this way, in fact, we may obtain from the green tissues of very different plants (even of such as possess in the tissues in question no known specific essential oil) a small quantity of a homogeneous essential oil, which separates from its solution in ether in colourless microscopic crystals, assuming the form of small, *curved*, isolated, dendritically-branched needles, which are remarkably similar to the hypochlorin-needles such as separate under microchemical treatment from the hy-

pochlorin-mixture in the cells. The agreement is especially striking in those cases in which the hypochlorin-needles occur in the interior of the cells *isolated* and *perfectly colourless*, or form *small dendritic aggregates*.

I must, however, report hereafter upon these experiments in distillation on the large scale and the products obtained in them; I chiefly refer to them here only for the purpose of indicating the probable connexion of their results with the changes which the chlorophyll-bodies undergo anatomically when they have been heated in water or exposed to hot aqueous vapour.

In favour of the assumption that hypochlorin is a volatile substance, and that a second non-volatile oil is present with it in the hypochlorin-mixture that may be prepared by hydrochloric acid, we have further the behaviour under heat of the *formed* hypochlorin-masses. Thus when green vegetable tissues, in which the hypochlorin-mixture has been separated by hydrochloric acid, and in which it has already acquired the forms of crystalline masses, scales, or nests, are *subsequently* boiled with water, or exposed to aqueous vapour, these segregations gradually lose their crystalline character and, if the action be continued long enough, become converted into clearly spherical oil-drops, which are then unalterable and persistent in heat, and, instead of the previous rust-coloured tint of the hypochlorin-masses, acquire more or less of a chlorophyll-green colour, becoming changed first into olive-green and then to bluish- or grass-green drops. But if long needles and filaments have already separated from the hypochlorin-mixture, the volatilization appears to be more difficult, although even these forms are attacked by the hot aqueous vapours if the distillation be continued for a considerable time.

From the anatomical facts here stated, therefore, the composition of the chlorophyll-bodies is more complex than it appeared to be from previous representations. The existence of oil in them is no exceptional case (here a substitute for deficient starch) confined to a few plants, or, as some people would have it, a pathological condition; but it is *generally diffused* and in essential connexion with the function of the chlorophyll-bodies. At the same time, the hypochlorin is contained in this oil—that colourless volatile substance, crystallizable on separation from the chlorophyll-bodies, which is present as a constant associate of chlorophyll in all chlorophyll-bodies which have been produced in the light.

Further, the phenomena which accompany the separation of the oil from the fundamental substance also furnish us with

information as to the *intimate structure* of the chlorophyll-grain, hitherto not noticed by anatomists, and as to the *local distribution* of the oil among the solid constituents of its fundamental substance.

With the exception of some still but imperfectly investigated cases (such, for example, as the generally known one of *Bryopsis*), and leaving out of consideration the sporadic or temporary occurrence of isolated and limited starch-inclusions, the chlorophyll-bodies of the uninjured cell usually produce the impression of homogeneous bodies, apparently consisting of homogeneous green substance. But when the hypochlorin and the oil are extracted from them by evaporation and hydrochloric acid, they are found to be *hollow bodies*, the cavities of which are filled with oil.

The framework of the solid substance exhibited by the chlorophyll-bodies when deprived of oil may, indeed, show subordinate modifications in its forms, according to the species of plant and the age of the tissue, especially when its shape has been influenced at high temperatures by the swelling of starch-enclosures; but, at the same time, the general structure of the chlorophyll-grain is always unmistakably manifested, as that of a *porous body, in the pores of which the oil has accumulated*. Its solid residues, if the grain has not been broken up into separate shell-like fragments by complete disruption, always represent more or less distinct and often exceedingly elegant *hollow bodies with perforated envelopes*, which latter may assume all possible forms of a retiform trabecular framework. These forms show themselves most distinctly, perfectly regular, characteristic, and always homogeneous when the extreme action of heat is avoided, and the process of removal of the oil is carefully conducted.

The right mode of proceeding must here be specially ascertained for each case, as it is influenced by the actual condition of development of the chlorophyll-body, and especially by the grade of development of its starch-enclosures. It is, however, always easily attainable, if the temperature and the duration of its action are suited to the given conditions. The tissues must be, according to their constitution, exposed for from a quarter to half an hour to the vapour of boiling water, or heated for about half an hour in water of 50°–80° C. (=122°–176° F.), and then left for at least one or two days lying in dilute hydrochloric acid. A good strength of the acid solution is one volume of hydrochloric acid to four volumes of water. The tissues may, however, remain for weeks or even months in the dilute hydrochloric acid without any alteration; and the structure of the chlorophyll-bodies thus gains, or at

any rate does not lose, in sharpness. If the chlorophyll-bodies contain but little starch or none at all, the tissues may without injury or even with advantage be boiled for a short time (about half an hour) in water before their treatment with hydrochloric acid. In many cases the reverse process (treatment first with hydrochloric acid and then the action of aqueous vapour) is more efficacious.

While by this mode of treatment the oil issues from the chlorophyll-grains, the latter appear in all plants as if differentiated into a denser and a softer mass, and acquire a sponge-like aspect. The places of the soft substance which form the meshes of a net of which the denser substance consists, soon appear as true cavities from which the oil has escaped. In this way the whole grain finally appears to be *perforated like a sieve*, producing nearly the characteristic impression of a regular sieve-plate; or in those cases in which the sieve-like perforation does not appear very sharply, it shows a spongy-porous texture which reminds one of the differentiations of substance which occur in many states of cell-nuclei.

The constancy and uniformity with which this spongy-porous structure is displayed by careful treatment in all chlorophyll-bodies proves it to be their normal structure. The solid constituents form the framework; the oil and the chlorophyll-colouring-matter dissolved therein saturate it and fill up its pores.

It is impossible that this concordant structure and this definite form of the solid constituents should always occur uniformly in all chlorophyll-bodies, if this differentiation and distribution of the solid and fluid constituents were not normally expressed in the chlorophyll-grain. It is only complete saturation with oil that causes the latter to appear homogeneous in the normal state; and the solution of the chlorophyll-colouring-matter in the oil is at the same time the cause of the absorption-spectrum of the chlorophyll-bodies and of green leaves appearing displaced towards the red end, in opposition to the absorption-spectrum of alcoholic and ethereal solutions of chlorophyll. For the oil and the hypochlorin, as is shown by every observation under the microscope, are powerful solvents of the chlorophyll-colouring-matter, and, at the same time (like other solvents also) determine the tone of colour and the absorption-spectrum of the solution of chlorophyll; and upon this also depend the different colour-phenomena which may be observed under the microscope during the separation of the constituents of the chlorophyll-grain, in the escaping drops and the residuary solid framework.

During these separations, moreover, it is always easily perceived that the chlorophyll-colouring-matter is a simple and not a composite colouring-matter; but even here such phenomena may occur as in Fremy's so-called splitting of the chlorophyll-colouring-matter into its component parts. I have already exposed in detail what is erroneous in this notion in my first memoir\* on chlorophyll. Here it will be sufficient, in order to exclude beforehand the same misconceptions of the colour-phenomena in the hypochlorin reaction, to call attention briefly to the fact that the chlorophyll-bodies in the tissues, like solutions of chlorophyll, when treated with hydrochloric acid, undergo a change of their tone of colour *before any separation* of the solid and fluid constituents, and acquire a golden-yellow tint. During the subsequent displacement of the hypochlorin and oil the greater part of the colouring-matter is carried away by these solvents, which thus, by its strong concentration in the separating drops, acquire the deep reddish-brown colour which renders the reaction so easily recognizable, whilst the solid frameworks remain more or less tinged with the grass-green or more bluish shades of the chlorophyll, and finally may appear but faintly tinted or even quite colourless.

## II. *Formation of Hypochlorin in the Seedling.*

The demonstration here given of the general diffusion of hypochlorin and oil in the chlorophyll-bodies, necessarily raises the presumption of a close relation between these bodies, which are so rich in carbon, and the most important physiological function, the assimilatory activity of the green tissues.

Starch no longer appears to be the most widely diffused, predominant, or even sole formed product, rich in carbon, of the chlorophyll-apparatus; and this circumstance increases the doubts which *à priori* exist against the view that the starch-enclosures separated in the solid form constitute the primary product of assimilation. Unquestionably, *à priori*, the properties of a fluid or volatile oleaginous substance are much more in accordance with this; and even the extant observations upon the relative magnitudes of the exchange of gases during assimilation render it extremely probable that its primary product is not a hydrate of carbon, but a body poorer in oxygen. Moreover, a periodical escape of oleaginous drops from the chlorophyll-bodies into the sur-

\* Monatsb. Berl. Akad. der Wiss., October 1874.

rounding protoplasm may in many cases be directly observed.

In this connexion the hypochlorin is especially worthy of notice, not only because it is never wanting in the fundamental substance of the chlorophyll-bodies, so far as these (as I shall show immediately) have been produced in the light, but also because it is apparently the only known substance which the seedling of the Angiospermia is unable to form from its reserve-materials without light. I have made a series of extended investigations on phanerogamous plants germinating in the dark in order to test whether a direct influence of light upon the formation of hypochlorin manifests itself.

I reared the seedlings from seeds in the dark until their reserve-materials were completely exhausted, and thus obtained the noteworthy result that the yellow etiolated seedlings at no stage of their development furnish indications of hypochlorin by the hydrochloric-acid reaction. This applies to all Angiospermia without exception; and although when we have to do with traces of a body in extensive tissues the demonstration of a negative result is a troublesome and tedious affair, and I have therefore hitherto been able to investigate only a moderate number of etiolated seedlings (*Finsterkeimlinge*) of various species, I can nevertheless, from the concordant results that I have obtained, assert with perfect certainty that not the least trace of hypochlorin occurs in the seedlings so long as they are not exposed to the light. This body originates in them only under the influence of light, after a longer or shorter action of the light upon the tissues which become green, and indeed at any age at which the etiolated young plant is exposed to the light, provided it is still capable of development. The rapidity of the viridescence of etiolated seedlings in the light depends, as is well known, upon the temperature and the intensity of light; and therefore, if one does not wish to employ artificial illumination and warmth, it is not a matter of indifference in what months the experiments are made. This applies also to the formation of hypochlorin in them.

I made my experiments in the summer months of July and August, with an average temperature of about 20°–23° C. (68°–73°·4 F.) in the place where they were carried on. At this high temperature of the air the etiolated seedlings become distinctly green in two or three hours when exposed to bright daylight, and in from 6 to 8 or, at the utmost, 10 hours they become quite a strong or even deep green.

On the investigation of the green tissues with hydrochloric

acid it then seemed that the formation of chlorophyll apparently long precedes that of the hypochlorin. To give an idea of the course of the phenomenon, I here append a few comparative data for etiolated seedlings of peas, hemp, cucumbers, and flax.

Etiolated seedlings 8–13 days old of these species of a *deep yellow* colour (the cotyledons of the cucumbers, as is often the case with these plants in spite of their having lived in the dark, having already a suspicion of green) show no trace of hypochlorin in their tissues when tested with hydrochloric acid.

Etiolated seedlings 8 days old, of the same plants and the same sowing, are rendered distinctly or even dark green by six hours exposure to light; but their tissues show no trace of hypochlorin.

Etiolated seedlings 8 days old, of the same sowing, exposed for 13–16 hours uninterruptedly to clear diffused daylight, behave similarly, although already dark green. No hypochlorin is yet to be found in their tissues.

Etiolated seedlings 8 days old, of the same sowing, placed in the light for 19–20 hours, show the first traces of hypochlorin, although on the whole sparingly.

Etiolated seedlings 8 days old, of the same sowing, exposed for 30–31 hours to full daylight, are full of hypochlorin. The plumules of the peas and hemp, the green tissue of the cotyledons of the cucumbers and flax, even the young scarcely coloured cells of their viridescent tissue, are now rich in hypochlorin.

From these investigations, therefore, it undoubtedly appears that in the Angiosperms the hypochlorin originates under the influence of light, and at the same time that it only becomes perceptible in them at a later period than the chlorophyll-colouring-matter.

There is undeniably a relation between the two substances. Does one of them proceed from the other? I cannot here go into this question, but will only point out that, from these experiments, as well as from the previous demonstration of its volatilization *without* destruction of the colouring-matter, the independent existence of the hypochlorin side by side with the chlorophyll-colouring-matter in the plant may be deduced with certainty. The green tissues, although they already contain the colouring-matter, nevertheless, when treated with hydrochloric acid, show no hypochlorin when they have not been exposed to the light for a considerable time. The hypochlorin therefore cannot originate only in the preparation from the colouring-matter, but must exist in the



plant together with the latter. This becomes still more distinct, and the connexion of assimilation with the formation of hypochlorin is rendered still clearer, when the above-described experiments on seedlings are slightly varied.

The viridescence of plants takes place, according to present notions, under a less intensity of light than assimilation. In half-obscurity, *i. e.* in strongly darkened places, therefore, seedlings become perfectly green, without, however, being able to keep themselves alive. They perish, not much later than when they vegetate in complete darkness. Although I regard the assumption that assimilation is entirely suppressed under small intensities of light as an error, the process is undoubtedly prejudiced; and therefore the accumulation of products rich in carbon, which the seedling requires after the consumption of its reserve-materials, is impossible under light of small intensity.

I have accordingly repeated the experiments on the production of hypochlorin with seedlings which I reared, not in the dark, but from the time of their germination in *half-obscurity*. In these, even in such as had lived from eight to fourteen days in half-obscurity, I likewise found no trace of hypochlorin, although the cotyledons, plumules, and primordial leaves of these little plants were well developed, and, especially, although these organs were as deeply and perfectly greened in the half-obscurity as is the case in seedlings which have been able to develop themselves quite freely and in full light for several days.

As a matter of course the result depends upon the light under which the plants grow; for even under moderate daylight in the place of experiment hypochlorin is present in the viridescent seedlings, and its quantity visibly increases with the increase of the light.

It is nevertheless not difficult to rear *beautifully green* seedlings without any trace of hypochlorin. This may be done, for example, by growing the plants in the experimental room at a great distance from the window and under bell-glasses covered with grey paper.

The just-demonstrated dependence of the formation of hypochlorin upon the influence of light would not *per se* prove a *direct* close relation to assimilation, but only indicate (as in the case of starch, fat, cellulose, and sugar) that it belongs to the series of those materials the storing up of which, as nearer or more remote products of assimilation, must necessarily be dependent upon the accumulation of carbon in the plant caused by light. This would certainly be the case if, in the instance of hypochlorin, as with the above-mentioned sub-

stances, we had to do only with an increase of the existing quantity in the light. But this is not the case; not merely have we to do here with an *increase of the existing quantity*, but hypochlorin, out of the whole series of materials which can come under consideration here, and especially of those which demonstrably occur together with it in the chlorophyll-apparatus, is the only one which cannot without light form itself in the seedling from the reserve-materials. Starch, oil, cellulose, and sugar, as is well known, reciprocally proceed from one another in the exchange of materials in the etiolated seedling, even without light. The green modification of the chlorophyll-colouring-matter alone has, in most Angiosperms, this property, in common with hypochlorin, of being unable to originate without light from the reserve-materials of the seedling; and this agreement of the two substances in such a decisive physiological point is certainly a noteworthy indication of common relations to the processes of assimilation, and of a direct interdependency.

The striking analogy shown by chlorophyll and hypochlorin in their relation to light in the Angiosperms extends very remarkably to the exceptional conditions of chlorophyll-formation in the Gymnosperms. As the Gymnosperms are the only Phanerogams whose seedlings can, in some unexplained fashion, form chlorophyll-colouring-matter in the dark, so also, singularly, the Gymnosperms are also the only ones in whose seedlings hypochlorin makes its appearance even in darkness.

I have paid particular attention to this peculiarity of the seedlings of Gymnosperms, and tested it in a great number of comparative investigations on seedlings of *Pinus picea*, *montana*, *maritima*, and *Larix* grown in the dark.

Without going into a detailed description of the results and of the relation of the quantity of hypochlorin present to the age of the seedlings examined, I may here sum up the general result of this series of investigations as follows:—In the Coniferæ just mentioned hypochlorin occurs even in seedlings grown in the dark; and it may be indubitably ascertained that the viridescence of these seedlings in the dark precedes the presence of hypochlorin in them.

It is true that frequently, especially in *Pinus picea* and *montana*, there are scarcely any traces of hypochlorin in the viridescent cotyledons even in seedlings several weeks old (almost as late as the third week of germination); but, on the other hand, other examples of the same species already show noteworthy quantities of it; and if the little plants grow older in the dark, say about four or five weeks, it may be easily

detected in every cell of the green tissue, especially in *Pinus maritima*.

From the facts here communicated I believe that I have, in the first place, established anatomically and microchemically the individuality of the hypochlorin in the chlorophyll-bodies, and proved the necessity of light for its formation in the Angiosperms. With regard to the physiological relations of chlorophyll to hypochlorin I have already given some intimations, and expressed the opinion that chlorophyll, by means of its absorption of light, protects the hypochlorin from combustion in intense light. Upon the presumable genetic relations of chlorophyll to hypochlorin my investigations are not yet completed.

XXXII.—*On a Collection of Lepidoptera from Madagascar, with Descriptions of new Genera and Species.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE following species have been selected from a large collection made at Fianarantsoa by the Rev. W. Deans Cowan.

## RHOPALOCERA.

### Nymphalidæ.

#### SATYRINÆ.

##### 1. *Gnophodes betsimena* ♀.

*Cyllo betsimena*, Boisduval, Faune Mad. p. 58. n. 1 (1833).

A fine specimen.

In my Catalogue of Fabrician Lepidoptera I erroneously sunk this species as a synonym of *G. pythia*; now that we possess both I find the Madagascar species much nearer to the *G. parmeno* of Trimen from Natal, which is of the same size and form, but instead of a broad oblique white belt on the primaries has a rather narrow angulated ochreous one. As the *G. parmeno* of Trimen is not identical with the West-African form, I propose to call it *G. diversa*.

##### 2. *Pseudonympha subsimilis*.

*Pseudonympha subsimilis*, Butler, Ann. & Mag. Nat. Hist. ser. 5, vol. iv. p. 228. n. 3 (1879).

The type was also taken at Fianarantsoa.

3. *Pseudonympha Cowani*, sp. n.

Allied to the preceding, but considerably larger; above with a white subapical spot replacing the ordinary subapical ocellus, and the secondaries with two ocelli as in *P. ankova*; the large ocellus of primaries and the dark submarginal lines as in the allied species. Under surface of primaries similar to *P. ankova*, but with the outer border creamy white, with dark brown submarginal and marginal lines, a cream-coloured subapical patch followed by two or three snow-white dots: secondaries cream-coloured, the central belt broadly zigzag; both it, the basal, and abdominal areas mottled with brown; three large ocelli, one at costa near apex, the others on the median interspaces; two slightly undulated submarginal lines and the fringe brown. Expanse of wings 1 inch 8-9 lines.

4. *Pseudonympha ankova*.

*Mycalesis ankova*, Ward, Ent. Month. Mag. vii. p. 31 (1870); Afr. Lep. p. 15, pl. 12. figs. 3, 4 (1874).

5. *Pseudonympha ibitina*.

*Mycalesis ibitina*, Ward, Ent. Month. Mag. x. p. 60 (1873).

A slight variety with unusually distinct markings on the under surface.

6. *Pseudonympha turbata*, sp. n.

Wings above fuliginous brown: primaries with two large white-pupilled and red-zoned black ocelli upon the disk, the lower one twice the size of the upper; fringe grey: secondaries with three ocelli, two of medium size on the median interspaces, and the third very small upon the radial interspaces; a feebly indicated submarginal dusky line; fringe grey. Wings below olivaceous brown, indistinctly mottled with darker lines: primaries with four abbreviated ferruginous streaks across the discoidal cell, the second of these streaks extending slightly below the cell; a ferruginous angulated stripe beyond the cell, its lower portion broadly arched, so as to bound the inner edge of the large inferior ocellus; the latter also has a ferruginous external border; the subapical ocellus extremely small, with scarcely a trace of the red zone of the upper surface; a subapical dusky patch upon the outer margin: secondaries with the disk slightly lilacine; the margins of the ordinary belt irregularly angulated somewhat as in *P. ankova*, the external border dark brown at apex; a discal series of six minute spots, the first punctiform and black, the three following punctiform but white, the last two

slightly larger, black with white pupils. Expanse of wings 1 inch 7 lines.

CALLYPHTHIMA, gen. nov.

Allied to *Pseudonympha* and *Ypthima*, but the male with more prolonged subangulated primaries, the female with broader and consequently less evidently subangulated primaries than in the male: the secondaries distinctly longer than in the above-mentioned genera, with a distinct abdominal angle forming a feebly pronounced anal lobe; palpi larger and much more hairy. Type *C. Wardii*.

7. *Callyphthima Wardii*.

♀. *Pseudonympha Wardii*, Butler, Cist. Ent. ii. p. 390 (1879).

♂. Smaller than the female, and altogether darker on both surfaces. Expanse of wings 1 inch 6 lines.

This species appears to be not uncommon.

8. *Ypthima rakoto*.

*Erebia rakoto*, Ward, Ent. Month. Mag. vii. p. 30 (1870).

This species is extremely close to *Y. Vinsonii*, but smaller and with the disk of primaries below less distinctly greyish white; the ocelli on the under surface of secondaries are placed one on the first median interspace and the other on the superior subcostal interspace in both of our examples.

9. *Ypthima Batesii*.

*Ypthima Batesii*, Felder, Reise der Nov. Lep. iii. tab. 68. figs. 10, 11 (1867).

A female example, thus placing the distinctness of *Y. niveata* beyond a doubt.

10. *Mycalesis perdita*.

*Mycalesis perdita*, Butler, Ann. & Mag. Nat. Hist. ser. 5, vol. ii. p. 283. n. 2 (1878).

11. *Mycalesis bicristata*?

*Mycalesis bicristata*, Mabille, Bull. Soc. Zool. France, vol. iii. p. 81 (1878).

I have to thank Mr. Moore for lending me a copy of the memoir in which this species is described.

NYMPHALINÆ.

12. *Charaxes cinadon*.

*Charaxes cinadon*, Hewitson, Ent. Month. Mag. vi. p. 177 (1870).

A pair of this fine species, somewhat damaged.

This species was originally described from a Natal male example in Mr. Ward's collection; it was subsequently sunk as a synonym of my *C. Druceanus* from the West Coast; it is intermediate in character between the latter species and *C. phraortes*, being the size of the latter.

### 13. *Charaxes Cowani*.

♂. *Charaxes Cowani*, Butler, Ann. & Mag. Nat. Hist. ser. 5, vol. ii. p. 285. n. 6 (1878).

♀. Similar in pattern to the male, but with the ground-colour of the basal area above ochraceous. Expanse of wings 3 inches 10 lines.

The male seems to be not uncommon.

### 14. *Panopea apaturoides*.

*Panopea apaturoides*, Felder, Reise der Nov. Lep. iii. p. 416. n. 643 (1867).

*Pseudacraea drusilla*, Saalmüller, Bericht über die Senckenbergische naturforschende Gesellschaft, 1878, p. 81. n. 25.

This species varies somewhat in size and in the distinctness of the submarginal white dots on the upper surface of the wings.

### 15. *Panopea diffusa*, sp. n.

Allied to *P. dubia* and *P. Bewsheri*, nearest to the former, but differing as follows:—Primaries with the oblique sub-apical series of spots forming a single trifid band, which externally is diffused and lilacine greyish, almost as in *P. anthedon*; the large white patch across the median interspaces continued downwards in the form of a diffused greyish nebula to the submedian vein; the abdominal area of secondaries dark brown (as in *P. Bewsheri* and *P. Drucei*) instead of broadly testaceous; five prominent rounded submarginal white spots on these wings. Expanse of wings 3 inches.

### 16. *Hypanartia hippomenes*.

*Hypanartia hippomenes*, Hübner, Samml. exot. Schmett. (1816–24).

This species occurs also in Natal, as does the *H. hippomenes* of Boisduval. The latter is a perfectly distinct species, much larger, longer in wing and tail, with duller coloration on the under surface and very different pattern for this species I propose the name of *H. commixta*.

## Lycænidæ.

### LYCÆNINÆ.

### 17. *Castalius auratus*, sp. n.

Golden cupreous above, with the veins, internervular folds,

two blue-centred anal spots in the secondaries, and the body above black; wings below snow-white, with brown-edged markings similar in form and position to those in *C. Poggei* (Dewitz in Nova Acta Acad. Leop.-Carol. Nat. Scr. p. 33, pl. xxvi. fig. 7), but not filled in with black as in that species. Expanse of wings 1 inch 1 line.

This species may be readily distinguished from the West-African *C. Poggei* by the metallic golden coloration of the upper surface, and the slenderness and length of the inter-nervular black streaks, in which last character it agrees with *C. juba* ♂, Fabr. (*Plebeius Falkensteinii*, Dewitz), figured in my Fabrician Catalogue, pl. ii. fig. 9.

### 18. *Castalius leucon*.

*Lycæna leucon*, Mabille in litt.

This species having only at present appeared in an advertisement-sheet (Pet. Nouv. ii. p. 289, 1879), I cannot regard it as a published species; it may, however, be the female of my *Castalius azureus*, from which it differs on the under surface in the absence of the discal series of black spots on the primaries.

## Papilionidæ.

### PIERINÆ.

### 19. *Nychitona sylvicola*.

*Leucophasia sylvicola*, Boisduval, Faun. Madag. p. 20 (1833).

The black apical patch is strongly marked in this example precisely as in our *N. medusa*.

The pure white species is apparently referable to *N. nupta*.

### 20. *Terias aliena*, sp. n.

Above bright sulphur-yellow, paler upon external border; primaries with a pale brown regular apical border: secondaries subangulated. Wings below uniform sulphur-yellow: primaries with a squamose dark brown dot in the cell; two dots on the discocellulars, a large quadrate apical patch, and the greater part of the outer margin pale orange: secondaries with two widely separated dots near the base, two lunate markings below the first and second median branches, and two small annular markings on the discocellulars brown; a subcostal dash, a broad oblique subapical streak, and a lunate marking on the second median interspace orange; veins terminating in extremely minute black points; fringe saffron-yellow. Expanse of wings 1 inch 5 lines.

Unfortunately only one example of this singular *Terias* has been received.

## 21. *Catopsilia decipiens*, sp. n.

♂. Above white, tinted with sulphur-yellow, which becomes more intense towards the middle of the wing; primaries with the costal border and basal third bright gamboge-yellow, outer edge of the basal area trisinate and oblique; secondaries with the basal half, excepting on abdominal border, bright gamboge-yellow; the usual pinky-white subcostal elongated mealy patch: head pale greyish flesh-colour; collar of the same colour in front, but greenish behind; thorax and base of abdomen greenish sulphur, remainder of abdomen white; antennæ above grey, with orange-tipped blackish club, below pale buff. Primaries below with the lower half of the cell and interno-median area bright sulphur-yellow, diffused externally; the usual thick sulphur-yellow scent-fan on internal border; disk white; costal, apical, and external areas cream-coloured: secondaries and pectus cream-coloured, venter white. Expanse of wings 2 inches 8–11 lines.

♀. Wings above white: primaries with the basal two fifths bright sulphur-yellow; a large black spot at the end of the cell; costal border testaceous at base, otherwise dark brown; apical and external borders rather narrowly dark brown, the latter broken up into spots towards the external angle; an angulated series of four widely separated but nearly equidistant dark brown spots across the disk: secondaries with the lower part of the cell and interno-median area tinted with sulphur-yellow; an indistinct irregular discal series of spots, and a still less distinct marginal series brown: head and collar pale purplish brown; tegulæ the same colour at the base, but tipped and fringed with whitish; thorax blackish, clothed with greenish-white hairs; abdomen white. Primaries below with an orange streak at the base of the cell, and a greyish annulus on the discocellulars, otherwise as in the male; secondaries and body as in the male. Expanse of wings 2 inches 8 lines.

Of this interesting species Mr. Cowan sent two males and one female; it takes the place of *C. crocale* in Madagascar, just as *C. thauruma* does that of *C. catilla*.

## 22. *Belenois coniata*.

*Belenois coniata*, Butler, Cist. Ent. ii. p. 391 (1879).

The present example measures only 2 inches 1 line in expanse of wing. The species seems not to be uncommon.



## Hesperiidæ.

### 23. *Hesperia ratek*.

*Thymele ratek*, Boisduval, Faun. Madag. p. 61, pl. ix. fig. 1 (1833).

The figure of this species is barely recognizable; but, fortunately, the description enables one to determine it satisfactorily.

### 24. *Hesperia fervida*, sp. n.

Primaries above fuliginous brown: secondaries deep orange, with the costal border, the external border to just beyond the first median branch, and a triangular spot at the extremity of the submedian vein fuliginous brown; abdominal border yellowish; fringe black at anal angle and at extremity of submedian and first median branch: head above green, spotted with white; palpi black and white; thorax testaceous, sprinkled with dark green hairs; abdomen brown, banded with ochraceous. Primaries below brown: secondaries silvery white, with the abdominal area broadly brown; anal angle ochreous, external border to submedian vein rather broadly brown: head below white: body brown, clothed with ochreous hairs; legs ferruginous; anterior coxæ orange, anterior tibiæ with a white stripe above. Expanse of wings 2 inches.

One example.

Nearest to *H. pisistratus* from West Africa.

### 25. *Cyclopides pardalina*.

*Cyclopides pardalina*, Butler, Ann. & Mag. Nat. Hist. ser. 5. vol. iv. p. 233. n. 15 (1879).

## HETEROCERA.

### Sphingidæ.

### 26. *Hemaris apus*.

*Macroglossa apus*, Boisduval, Faun. Madag. p. 79, pl. x. fig. 4 (1833).

Dr. Boisduval's figure is by no means characteristic.

### 27. *Nephele malgassica*.

*Zonilia malgassica*, Felder, Reise der Nov. Lep. iv. tab. lxxvi. fig. 2.

Felder's representation of this species is altogether too green.

### Agaristidæ.

### 28. *Eusemia metagrius*, sp. n. (no. 58).

Above deep chocolate-brown: primaries crossed just beyond the middle by a pale yellow band, as in *E. agrius*; base of

costal border black, with two yellow dots and a metallic plumbaginous spot: secondaries with a broad, irregular, pale yellow patch from the origin of the subcostal branches to the submedian vein; basal area of a rather paler brown than the external area; head and collar black, spotted with yellow; abdomen black, banded with dull orange. Primaries below with the base bright ochreous, otherwise as above: secondaries with the basi-abdominal area occupied by a broad subquadrate pale yellow patch, washed at base with ochreous; three submarginal white dots: body below dull ochraceous. Expanse of wings 2 inches 2 lines.

In coloration this species is not unlike *Rothia Westwoodii* (*Eusemia virguncula*?, Mab.); but the form is quite different.

### 29. *Eusemia tranquilla*, sp. n.

Allied to the preceding species, but darker, the belt of primaries of double the width and less oblique: secondaries with the base purplish black; a broad patch of pale green sprinkled along its inner margin, with orange scales which form a distinct spot upon it just within the extremity of the discoidal cell: the body less distinctly banded. Primaries below with the band even wider than above, the base bright orange: secondaries bright orange, with the outer two thirds of costal border, the apex, and external border deep brown. Body ochreous, venter banded with black. Expanse of wings 2 inches 1 line.

This is of the same form as *E. metagrius*.

(Zygænoid) **Arctiidæ**.

**MYDRODOXA**, gen. nov.

Body and legs very robust, wings broad. Primaries with straight costal and convex inner margin, outer margin slightly convex; costal vein extending to second third of costa; subcostal six-branched, first branch emitted before the end of the cell, united by a cross spur with the second, which is emitted from the end of the cell, and from below which the remaining four are thrown off; the sixth branch is in reality the upper radial; upper discocellular strongly angulated, lower extremely short, so that the lower radial almost looks like a fourth median branch. Secondaries subtriangular; neuration normal—that is, the costal vein extending to apex, the subcostal two-branched (although the branches are emitted from a short footstalk), discocellular angulated, median three-branched, submedian and internal veins as usual. Type *M. splendens*.

30. *Mydrodora splendens*, sp. n.

Primaries above with the basal two thirds fiery cupreous, gradually shading off into golden green at the margins and crossed by a broad, velvety, greenish-black belt; external third dark shining blue-green; base of inner margin shining dark green: secondaries shining steel-blue, greenish in certain lights, with the base and costal border blackish: frons, collar, pro-, and mesothorax velvety black; three basal segments of abdomen and body below steel-blue, varying to dark green; vertex of head, metathorax, the four posterior segments of abdomen, and anal tuft carmine-red. Wings below golden green, changing to blue-green towards the internal borders; internal border of primaries purple. Expanse of wings 1 inch 9 lines.

This magnificent moth reminds one, in the size, form, and coloration of its wings, of the New-World genus *Eupryra*; in its shorter head and shorter and more slender palpi, and in its neururation, it approaches more nearly to the typical *Arctiidæ*.

(Typical) *Arctiidæ*.31. *Daphænura fasciata*.

*Daphænura fasciata*, Butler, Ann. & Mag. Nat. Hist. ser. 5, vol. ii. p. 457 (1878).

The specimen now received exhibits a structural character not visible in the typical examples, but first pointed out to me by Mr. Druce in specimens in his collection: the male possesses an enormously developed pair of scent-fans in the form of broad compressed curved brushes, apparently jointed at the base, and capable of retraction behind the hairy clothing of the posterior coxæ. In my typical male these fans are completely concealed; but in the specimen now obtained they are fully exerted, are of a sandy yellow or testaceous colour, and are 4 lines in length.

## EPICAUSIS, gen. nov.

Body broad, long, robust, hairy, with enormous anal tuft; antennæ thick, very feebly pectinated; palpi moderately long, distinctly visible in front of the head. Primaries very long, subtriangular, with straight costal and slightly convex external and inner margins; costal vein extending to fourth fifth of costa; subcostal five-branched, first branch emitted from third fourth of anterior margin of cell, other veins exactly as in *Acronycta* (see Trans. Ent. Soc. 1879, pl. xi. fig. 1). Secondaries short, about half the length of primaries,

with slightly convex costa and outer margin and straight abdominal margin; costal vein extending to apex; discoidal cell extending to the middle of the wing; subcostal with two branches emitted from a long footstalk beyond the cell; discocellular long and angled; lower discocellular short and slightly elbowed; median vein three-branched, the second and third branches emitted from a very short footstalk; submedian and internal veins as usual. Type *Epicausis lanigera*.

### 32. *Epicausis lanigera*, sp. n.

Wings bright orange, with black external borders: primaries with four transverse black abbreviated dashes upon the basal area; two broader black dashes upon the apical half of costa; two black dashes on basal half of internal border, and two more near the external angle; external border distinctly dentated on its inner margin: secondaries with the basal two fifths black, clothed at the base with ochreous hair; outer border regularly and rather broadly black: head, thorax, and anal tuft carmine; abdomen velvety black. Wings below paler orange than above, with black external border, that of primaries emitting a subapical curved band (at lower radial vein), which runs inwards to the costa; a black spot near the base of costa, and a black patch at base of interno-median area: secondaries with the interno-basal area black: body below black, with the subanal segment broadly fringed with carmine; anus black, anal tuft carmine as above. Expanse of wings 2 inches 5 lines.

Three examples, two of which are in moderately good condition, were sent home.

### **Lithosiidæ.**

#### ISORROPUS, gen. nov.

Allied to *Dyphlebia*, but with broader wings. Primaries with the costal vein terminating at second third of costa; subcostal five-branched, the first two branches emitted before the end of the cell and united by an oblique spur or veinlet to the third branch, which is emitted from the end of the cell and is trifurcate; only one radial emitted from the end of the cell, at the same point with the third subcostal branch; discocellular angulated; median vein three-branched, the last two branches emitted from a long footstalk. Secondaries with the costal vein reaching to apex; subcostal forking from the costal at basal fourth, emitting its two branches from a long footstalk beyond the end of the cell; cell reaching to the

middle of the wing, discocellular strongly angulated; median vein emitting its second and third branches from a very long footstalk. Body similar to *Dyphlebia*. Type *I. tricolor*.

33. *Isorropus tricolor*, sp. n.

Wings bright orange, with broad black-brown outer borders, widest upon the costal margin; primaries with a broad black-brown central belt, both border and belt on these wings shot with dark green: body carmine-red. Expanse of wings 1 inch 5 lines.

Two examples of this species were sent home; but one of these is so much worn and broken as to be valueless; the type is in fairly good condition.

34. *Sommeria extensa*, sp. n. (no. 15).

Primaries chalky white; five black dots at the base followed by a short dark brown costal dash, two black dots in the cell and two near the base of interno-median area; a zigzag central olive-brown stripe from costa to inner margin, an oblique series of fusiform olive-brown spots from the end of the cell to the costa, and an indistinct irregularly angulated discal series from apex to external angle: secondaries cream-coloured: thorax white, black-spotted; abdomen ochreous, with dorsal and lateral series of black spots; antennæ black. Primaries below paler than above; costal borders testaceous; black dots obsolete, brown markings indistinct: secondaries sordid white, with testaceous costal border and veins; body below white, pectus black-spotted. Expanse of wings 1 inch 10 lines.

One example only; it is most nearly allied to *S. privata*, but is considerably larger, with much longer wings.

*HYP SINÆ.*

35. *Aganais borbonica*.

*Aganais borbonica*, Boisduval, Faun. Madag. p. 96, pl. xv. fig. 1 (1833).

I cannot believe that this is the male of the following, the sexes of all the other species being extremely similar, and the supposed female being of the same form and coloration as the species of *Damalis*.

36. *Damalis insularis*.

*Aganais insularis*, Boisduval, Faun. Madag. p. 97, pl. xv. fig. 2 (1833).

Nearly allied to *D. egens*.

## Nyctemeridæ.

37. *Nyctemera biformis* ♂.

*Nycthemera* (sic) *biformis*, Mabille, Bull. Soc. Zool. France, vol. iii. p. 88 (1878).

38. *Hylemera fragilis*.

*Hylemera fragilis*, Butler, Ann. & Mag. Nat. Hist. ser. 5, vol. iv. p. 236. n. 24 (1879).

Previously received from Antananarivo.

[To be continued.]

## MISCELLANEOUS.

*On the Resistance of Aphides to Severe Cold.*

By M. J. LICHTENSTEIN.

THE author remarks that he has endeavoured to show that, just as a plant can reproduce itself by seeds and by buds, the vine-*Phylloxera* (*P. vastatrix*) is also able to reproduce both by fecundated eggs and by subterranean budding colonies—the duration of which latter may be as indefinite as that of the plant, given the necessary nourishment and warmth. This last condition seems indispensable for the agamic reproduction, but not for the existence of the insect.

During December last, when temperatures of  $-11^{\circ}$  or  $-12^{\circ}$  C. ( $= +12^{\circ}\cdot 2$  or  $10^{\circ}\cdot 4$  F.) prevailed, the author found not only that the underground *Phylloxera* did not suffer at all, but that he could collect upon trees and plants in his garden numerous Aphides (he mentions *Aphis persica*, *euonymi*, *hederæ*, *brassicæ*, and *capsellæ*, and *Rhopalosiphon berberidis*), all stupefied by the great cold and often covered with snow or hoar-frost, but perfectly alive. The Aphides were all in the budding phase; but close by them, upon the same plants, there were eggs laid in the autumn by the fecundated females, which had long before disappeared.

The Aphides were carried into a room at a temperature of  $8^{\circ}$ – $10^{\circ}$  C. ( $= 46^{\circ}\cdot 4$ – $50^{\circ}$  F.), and the twigs to which they adhered planted in damp sand. In two or three days they all began to breed, bringing forth living young. Suspended by the cold, the faculty of gemmation was by no means extinct.

As there are perennial and annual plants, so among the Aphides there are species which die out every year, except the eggs, and others with indefinite reproduction by gemmation. All the above species are perennial; and it is curious that while warmth immediately causes the false females, or budding pseudogynes, to recommence their gemmation, the true egg does not hatch, and seems to await the shooting of the plants upon which it is fixed.

M. Lichtenstein believes that the annual species are much more numerous than those of unlimited duration. Thus the *Phylloxera* of the oak (*P. quercus*, *coccinea*, and *corticalis*), the Aphides of the

elms (*Tetraneura* and *Schizoneura*), and those of the poplar and pistachio (*Pemphigus* and *Aploneura*), or, at least, some of them, have a period during which the egg alone exists. From the 1st to the 6th January, however, the author found great numbers of *Vacuna dryoptrica*, male and female, in copulation under the leaves of an oak (*Quercus pubescens*).—*Comptes Rendus*, Jan. 12, 1880, p. 80.

*Experimental Researches on the Phosphorescence of the Glowworm.*

By M. JOUSSET DE BELLESME.

Electricity, the nervous fluid, insolation, and the vital forces have been invoked by turns as causes of phosphorescence. Finally we have rested upon the existence of a phosphorescent matter emitted by luminous animals, which appeared more probable. I have thought it necessary to examine afresh this phenomenon in the glowworm, because the investigations made by Matteucci, the principal experimenter who has paid attention to the matter, were by no means irreproachably conducted. In fact, neither this author nor others have, in their experiments, taken into account the will of the animal, or endeavoured to eliminate that cause of uncertainty; so that when they placed a glowworm in carbonic acid, for example, they could not exactly determine whether the phosphorescence ceased because the medium did not allow of its being produced, or because the animal voluntarily refused to shine. It was necessary, in the first place, to become master of the phenomenon, and for that purpose to prevent the animal from shining at its own pleasure, and force it to become luminous at that of the experimenter. With this view, I remove the cephalic ganglia, which abolishes all spontaneous phosphorescence; then I replace the voluntary excitation by the passage of a moderate electrical current in the trunk or in the luminous organ. This excitation causes, with certainty, a brilliant phosphorescence.

Possessed of this process, I proved, as Matteucci had done, that the presence of oxygen is in fact absolutely necessary in order that the luminous apparatus should perform its function. The insect, prepared as just described, and immersed in carbonic acid or inert gases, such as nitrogen and hydrogen, and electrically excited in those gases, never becomes luminous.

We may therefore regard it as certain that the large cells with granular protoplasm forming the parenchyma of the phosphorescent apparatus produce a substance which becomes luminous by contact with the air conveyed by the numerous tracheæ with which this apparatus is furrowed.

In order to know what this matter is, it was necessary to be able to isolate it and analyze it. This has already been attempted. The resemblance of the luminosity to that of phosphorus has led several chemists to seek for that substance in the luminous apparatus; but their researches have been in vain, so that naturalists have found themselves in presence of two contradictory assertions. The present memoir shows that this contradiction is only apparent, and that it

arises from a bad interpretation of a well-known fact. When we crush a glowworm we most commonly see luminous traces persisting on the ground; from this it has been concluded that the case of its apparatus was the same as that of matches, and that these traces were nothing but a phosphorescent material accumulated in the apparatus for the ulterior needs of the insect. The experiment thus made is very defective; let us repeat it more methodically. If we confine ourselves to tearing up, with needles, a phosphorescent glowworm, the fragments remain luminous, at least for some hours. On the other hand, if we rapidly crush one of these insects in a mortar, so as to destroy the cells themselves, the phosphorescence immediately disappears; and the pulp, if collected, exposed to contact with pure oxygen, and subjected to the influence of electrical excitation, remains absolutely dark. Thus a partial crushing allows the phosphorescence still to be produced; complete crushing abolishes it. Upon the hypothesis of a store of phosphorescent matter, crushing carried very far would evidently be favourable to the production of light by spreading this matter over a large surface in contact with air; but the reverse of this takes place; the phosphorescence does not persist unless the apparatus is only reduced to fragments. This is due to the fact that groups of cells remaining intact continue to live and perform their functions. Tearing and the abnormal contact of the air excite them; and their protoplasm, reacting under these influences, produces the phosphorescent matter at the expense of the materials which it contains. If we kill these cells by crushing them, life no longer intervenes to set these materials at work and give them the chemical form under which phosphorescence can manifest itself.

We are therefore here in presence of a chemical phenomenon, but of one which is not produced in the glowworm, except under biological conditions. We can, moreover, prove this in another manner. Besides crushing, certain toxical agents have the power of destroying the cells. If we submit a glowworm to the action of sulphuretted hydrogen it is killed immediately. If we then take it and excite it electrically we obtain no light. The cells are intact as to their form, but physiologically destroyed; they no longer function. We may then tear the organ, and apply the action of oxygen and of electricity without provoking phosphorescence. It is certain, nevertheless, that this protoplasm contains all the materials chemically necessary for the production of the phosphorescent substance; but this substance is not ready made. It is only produced in proportion to the waste, under the influence of the will and by the intermediation of the nervous system, which excites the cells and causes them to enter into action. Phosphorescence is consequently a phenomenon of the same order as muscular movement, or the evolution of electricity in the apparatus of the torpedo, which are undoubtedly the result of chemical combinations taking place in the protoplasmic matter.

It is very probable that this phosphorescent substance is a gaseous product; for the structure of the gland, well investigated by Owsianikow, does not give us the idea of an organ with a liquid



secretion. Now the chemical products which are phosphorescent at ordinary temperatures are not numerous; and the one of which one is led to think is phosphuretted hydrogen. It is for the chemists to elucidate this point; but, in consequence of the peculiarities just indicated, they must not attempt to ascertain its presence directly, but rather to see whether there are, in the cellular protoplasm of the apparatus, the materials necessary for the production of this gas.

What inclines me in favour of this hypothesis is the extreme resemblance that we observe between the phosphorescence of substances in decomposition, which is due to an evolution of phosphuretted hydrogen, and that of luminous animals. They present the same physical characters, the same affinity for oxygen, and only differ in this particular, that the cadaveric phosphorescence is continuous, like the decomposition of the substances which produce it, whilst the phosphorescence of the animals is intermittent. The latter is due to the fact that the cellular decomposition which sets free the luminous product, takes place in animals of high organization only under excitation of the nervous system, and in the lower animals (*Noctiluca*) only by means of external excitants.

My investigations upon the glowworm and the experiments that I have made upon the *Noctiluca* lead me to regard phosphorescence as a general property of protoplasm, consisting in an evolution of phosphuretted hydrogen. This mode of looking at it easily explains how many of the lower animals, although destitute of a nervous system, are phosphorescent. Further it presents the advantage of enabling us to connect the phenomena of phosphorescence observed in living creatures with those which are observed in organic matters in course of decomposition. It is another example of a biological phenomenon very clearly reduced to an exclusively chemical cause.—*Comptes Rendus*, February 16, 1880, p. 318.

#### *On the French Jurassic Cidaridæ.*

By M. G. COTTEAU.

M. Cotteau, having completed the revision of the Jurassic Cidaridæ in the 'Paléontologie Française,' has communicated to the Geological Society of France an interesting summary of his results. Of French fossil urchins he refers to this family 121 species, of which 87 belong to the old genus *Cidaris*, 25 to *Rhabdocidaris*, and 9 to *Diplocidaris*. The 121 species all belong to the Jurassic epoch: none of them existed before it; and none occur in the Cretaceous deposits. Most of them are also limited to a single stage of the Jurassic.

The Rhætic stage contains a single peculiar species. The Sinemurian (Infra-Lias) has 7 peculiar species, mostly represented by detached spines. The Liassic stage possesses 10 species, 9 of which are confined to it, while the tenth extends up into the next stage, the Toarcian (Upper Lias shale), which, however, contains only 3 species in all. The species just referred to (*Rhabdocidaris horrida*) also passes into the Bajocian (Inferior Oolite) stage, in which the

number of Cidaridæ is very considerable, 24 French species being recorded by M. Cotteau. Of these, 19 are peculiar to the stage; 1, as already stated, is of older date; 4 pass into the next stage; and one of these (*Rhabdocidaris copeoides*) extends up through the two subsequent stages.

In the Bathonian (Great Oolite) we have 20 species, 13 of which are peculiar, 4 had previously appeared, and 5 extend up into higher deposits; 3 of them, however, do not occur in the next following stage, but only in the one above it. The Callovian contains only 6 species, 4 of which are peculiar, and 2 extend up into the succeeding stage, 1 of them belonging also to that below. The Oxfordian, including therein the zone of *Ammonites tenuilobatus*, has 24 species, 4 of which had already made their appearance in the Bathonian, while 7 others extend up into the Corallian, and one of them even into the Kimmeridgian stage.

The family attains its maximum in the Corallian stage, from which M. Cotteau records 38 species, 29 of which are peculiar to this series of deposits. Seven species, as already stated, come up from the Oxfordian, while 3 recur in the next stage, the Kimmeridgian, which, however, has altogether only 9 species. The Portlandian has only a single peculiar species.

M. Cotteau sums up his results as follows:—"Of 121 species of Cidaridæ which were developed in France during the period of the Jurassic formation, 104 are, as at present known, peculiar to the stages in which they are found, and only 17 occur in more than one stage.

"The three genera *Cidaris*, *Rhabdocidaris*, and *Diplocidaris* have each a different origin and destiny.

"The genus *Cidaris*, including the greatest number of species, is of all genera of Echinida the one that has persisted longest. It makes its appearance in the deposits of the Carboniferous formation; from this period it multiplies its species in all the stages of the Jurassic, Cretaceous, and Tertiary formations; and at the present day it still possesses representatives in most of our seas. Notwithstanding this long duration, from its first appearance to the present epoch it has undergone in its general characters only unimportant modifications, which often render it difficult to distinguish the species.

"The genera *Rhabdocidaris* and *Diplocidaris* have been separated from *Cidaris*. The former began to appear in the Liassic stage, and attains its maximum of development during the Jurassic epoch; it likewise exists in the Cretaceous and Tertiary formations and at the present epoch, but is much rarer. The second genus, *Diplocidaris*, is peculiar to the Jurassic formation, and indeed does not exist even in its last stages.

"Over and above the 121 species of Jurassic Cidaridæ described and figured in the 'Paléontologie Française,' the genus *Cidaris* has furnished us with 47 species, 44 of which are foreign to our country; the genus *Rhabdocidaris* with 10, and *Diplocidaris* with 3 species foreign to France; which raises the number of species of Jurassic Cidaridæ that we know at present to 181."—*Bull. Soc. Géol. France*, 3<sup>me</sup> sér. tom. vii. p. 246.

# THE ANNALS

AND

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XXXIII.—*On the Teleostean Affinities of the Genus Pleuracanthus.* By JAMES W. DAVIS, F.G.S. &c.

I PURPOSE in the following remarks to consider certain characteristics in a group of fishes now extinct, but whose fossil remains are found imbedded in the shales and coals of the Carboniferous series of rocks and in the marl slate of Permian age occurring in some parts of Germany. In the latter the fishes are found well preserved and more or less perfect. The anatomy of the fish and the relations of its various parts to each other are clearly defined. In the English Coal-measures, however, the fish has not been preserved so perfectly, and, as a rule, the spines and teeth are found generally distributed where fish-remains have been discovered to exist, but the remaining parts of the skeleton are wanting. The cannell coal between Bradford and Wakefield has yielded some specimens of the bones of the fish, in addition to a large and varied collection of spines and teeth. Prof. Agassiz described the spines of these fishes, and named them *Pleuracanthus* and *Orthacanthus*; and the teeth he also described, and designated *Diplodus*. The continental specimens were first described in 1847 by Dr. Goldfuss of Bonn, as *Orthacanthus Dechenii*. A year later Prof. Beyrich wrote a treatise on the same fish, naming it, however, *Xenacanthus Dechenii*. In 1855 Sir Philip Egerton pointed out that the spine *Pleuracanthus* and the *Diplodus*-teeth belonged to the same genus of fish,

and that the *Xenacanthus* of Beyrich was evidently the same; and, further, that *Orthacanthus*, from the great difference in the position of the denticles which extend along its dorsal margin, might constitute the only additional genus to *Pleuracanthus*. Since then a number of intermediate species have been discovered, which conduce towards proving that there can be no real division between *Pleuracanthus* and *Orthacanthus*, and that, consequently, the latter must be absorbed in the former.

The Bohemian specimens of *Pleuracanthus* appear to have been about 18 inches in length. They had a broad flat head, which contracted somewhat towards the body, the latter being narrower laterally, but of greater thickness from the dorsal to the ventral surfaces, and gradually tapering towards the tail. There were two pectoral and two ventral fins; and a dorsal fin extended along the back; beginning immediately behind the head, it encircled the tail and extended along the ventral aspect, nearly or quite to the position of the ventral fins. In front of the dorsal fin there was a straight fin-ray or spine about 5 or 6 inches long in a fish of the size mentioned; it was inserted in the neck, and appears to have been supported by muscles or cartilage, there being no process for articulation to a bony support. The spine in some instances possesses a row of denticles along each lateral surface; and in others the two rows of denticles are placed on the back of the spine and approximate closely to each other. It is composed of very close-grained, dense, bony substance, and, to all appearances, was not immediately connected with the dorsal fin. Besides these two varieties of the spines, which are found attached to the fossil fishes of the Continent, and which were originally described by Agassiz, in the 'Poissons Fossiles,' from detached spines found in the Coal-measures of Britain, others have been discovered in America, and described by Dr. Newberry in the Geological Survey of Ohio, also from the Coal-measures; and during the last year or two I have been fortunate in finding, in the cannel coal of West Yorkshire, other specimens with the denticles in various intermediate positions between the lateral (or *Pleuracanthus* type) and the dorsal (or *Orthacanthus* type), which go far to prove that this difference in the position of the rows of denticles is not of generic importance, and that the two must be united in the genus *Pleuracanthus*. I have expressed these views more fully in a paper recently read before the Geological Society of London.

The body of the fishes in some of the specimens was covered

by minute rhomboidal plates of enamel ; in the majority, however, this is not preserved and does not appear to have been present, the skin being naked. The head, much depressed, was very broad, and terminated in a rounded snout. The position of the eyes is not indicated in any of the fossils. A pair of orifices, placed a little distance behind the snout, appear to indicate, in the opinion of Dr. Goldfuss, that they may have been connected with the nostrils. The mouth extended in a semicircular form round the anterior portion of the head, the lower jaw projecting somewhat beyond the upper and being of very massive construction. The mouth was armed with several rows of closely-set, three-pronged, sharp teeth, extending one behind the other along each jaw, in a similar manner to those of the Sharks and Rays of existing species. These, found separately in England, were described by Prof. Agassiz, under the generic name of *Diplodus*.

The skeleton of the fish was, for the most part, cartilaginous. The vertebræ were wholly so ; but attached to them were bony ribs, short and slender. Connecting the spinal column and the dorsal fin were hollow (?) spinous and interspinous bones, which are preserved and were similar in character to the other hard parts of the skeleton, being composed of cartilage with innumerable osseous centres, the chondroid bone of Prof. Williamson.

Dr. Kner says it is certain that four or five gill-arches, set with a few long rake-like teeth, were present, the larger ends of which were surrounded by many slender gill-rays ; they were attached to the horny substance of the bones supporting the tongue. The connexion of the gill-supports with the shoulder-girdle resembled that of the *Squalidæ*. The shoulder-girdle does not join immediately up to the bones of the head, and is not united with the vertebral column, but, as in the cartilaginous fishes, it is situated so far back that several of the vertebræ are in front of it. Kner discovered three separate bones composing the shoulder-girdle, viz. the clavicle, scapula, and suprascapula ; whilst attached to these is a large, broad, bony plate composed of a single piece, which, in the hinder third part, is bent on its outer edge at right angles in the form of a knee ; from this springs an articulated straight ray, which extends the whole length of the pectoral fin. From the outer side of the articulated ray spring many fin-rays ; and on the inner side there are also a number of weaker rays. Altogether they form a very large and expanded pair of pectoral fins. In an example of

the pectoral fin from the shale above the West-Riding cannel coal the fin-rays are very strong, and placed near together. They present the characteristic chondroid structure; and each ray is composed of a number of separate segments, which do not appear to have been joined together except by the investing cartilage of the fin; the ends of the segments present no articulating surface. The structure of the pectoral fins of *Pleuracanthus* may be advantageously compared with the fin of the mud-fish (*Lepidosiren*).

The posterior or ventral fins are built up from the pelvic girdle in a manner similar to the pectoral. There is a pair of peculiar ventral shields, studded over with hook-like appendages, whose use has not been clearly defined. In some of the examples the ventral fins are much nearer together than in others; and where this is the case the bony appendages are absent. It was suggested by Prof. Geinitz, in his great work 'Der Dyas,' that the ventral shield might have been a sucker; and he believed the genus to have been allied to *Cyclopterus*. Dr. Kner, after examining all the specimens then accessible, came to the decision that the ventral appendages were hooking-organs, similar to the claspers found in sharks and in the sheat-fishes or Siluroids of the present day—this explanation being rendered probable from the fact that some of the fossil fishes are provided with appendages, whilst others are devoid of them, leading to the supposition that where the appendages were present the fishes were males, whilst the females would be the fishes without them.

The vertebral column was continued from the pelvis to the extremity of the caudal fin in a straight line. The vertebræ were cartilaginous and are not preserved. The rays supporting the fin were to some extent osseous, and are distinctly shown in some of the specimens.

The systematic position of *Pleuracanthus* is one very difficult to define. The thick cartilaginous ventral appendages incline to a resemblance to the Sharks; but in the structure of the skeleton, and especially in that of the fins, it does not in any way resemble the Sharks. The osseous rays and interrays which support the dorsal fin (the latter also being supported by bony fin-rays), the bony ribs with expanded bases for attachment to the vertebræ, and the possibility, indicated in some specimens, that some of the vertebræ themselves had osseous centres, all remind us of a strong resemblance to the type of bony fishes. The identification of the gill-arches bearing teeth, the projection of the gill-rays, and the presence

of teeth attached to the bones of the throat also characterize bony fishes. Against these Teleostean resemblances may be placed others which are again closely related with cartilaginous fishes, for example, the mosaic-like structure of the integument—though some of the Siluroid fishes are possessed of a rough skin almost like the shagreen of the sharks, and one very curious genus (*Sisor*) has the whole length of its back mailed with enamelled scales. The position of the shoulder-girdle, the suspensory jaw, and the attachment of the upper to the under jaw are similar to those of the Plagiostomous fishes. The spine, situated immediately behind the head, solid and circular or flattened in form, without the fin-investing hollow of the commoner *Ctenacanthus* or *Gyracanthus*, does not resemble the fin-spine of any existing shark; but, as was pointed out by Dr. Goldfuss, and afterwards insisted on by Prof. Beyrich, it appears to be closely related to the Rays (*Squatina*) both in form and method of attachment.

Many of the Siluroid fishes have spines very closely approaching those of *Pleuracanthus*; and it may be well to notice one or two examples. *Rita Buchananii*, Cuv. & Val., is about 7.5 inches in length. The head, covered with strong dermal plates, is 1.75 inch across, and very broad and depressed in comparison with its depth. The mouth is at the termination of the snout; it is large and has a wide gape; its jaws are armed with a large number of minute teeth; and others cover the palatal region of the mouth. The eyes are small. From the head the body of the fish tapers rapidly towards the tail. The skin is scaleless. There are two dorsal fins: the anterior one, situated 2.5 inches from the termination of the snout, is armed with a strong articulated spine; the posterior one is an adipose fin without rays. There are two pectoral, a pair of ventral, an anal, and the caudal fins. The pectoral fins are protected by strong bony spines. The features of peculiar interest lie in the spines attached to the anterior dorsal fin and the two pectorals. The latter are 1.6 inch in length and .2 of an inch broad; they are somewhat flattened, slightly curved, and end in a point. The upper and lower faces are very finely striated; and the two lateral extremities are armed with rows of recurved, long, sharp denticles, extending the whole length of the spine, but becoming smaller near the base. The dorsal spine is 2 inches in length, and of about the same diameter as the pectorals; it is much rounder than the pectorals, and tapers rapidly to a point. It curves slightly backwards, and on its posterior median surface has a single row of denticles

extending '6 of an inch towards the base; the anterior surface is produced so as to form a median keel, which extends all the length of the spine; towards the base this keel is corrugated, forming a line of rough granulations. The sides of the spine are slightly striated. All the spines have an internal pulp-cavity, but show no trace of the posterior hollow seen in the Elasmobranchs.

In numerous species there is a dorsal-fin spine, but no spines to the pectorals.

In a small specimen of *Macrones* from one of the Indian rivers there are two pectoral and one dorsal fins which have spines attached. They present a close resemblance to some of the spines of the fossil *Compsacanthus*. The pectoral fins are armed with a strong spine '5 inch in length. The spine tapers to a point. Its posterior face is straight, the anterior very slightly curved. It is somewhat flattened laterally, and ornamented with longitudinal striæ. On the median posterior surface is a row of denticles, which extend along the whole length of the spine exposed; the denticles are equal in length to the breadth of the spine, sharply pointed and slightly recurved towards the base. Attached to the spine is the pectoral fin, composed of seven or eight bifurcating fin-rays. The dorsal spine is about two thirds the size of the pectoral; it is straight, pointed, striated longitudinally, and has on its posterior surface a single row of short straight denticles, which point towards the base of the spine at an angle of  $45^{\circ}$ . It is not connected with the dorsal fin, but stands detached. It is implanted in a triangular bone formed by a prolongation of the bones composing the occipital region of the head.

As already explained, the spines of the Siluroids are attached by an articulation of greater or less complexity; but I must confess there does not appear to be any thing extraordinary in this difference. In *Pleuracanthus* the spine is adapted in the best way to the cartilaginous skeleton of the fish, whilst in the Siluroids, having a bony and firm base, nothing appears more reasonable than that, during the period of this development or change in the character of the skeleton of the fish, the spine should have been adapted to its support, and have acquired its present method of attachment. There is also the important consideration that the spines of the rays are all similar in character, with two rows of denticles situated on the lateral surfaces of the spine as widely separated as is possible; whilst those of the Siluroids exhibit every gradation from spines with the two rows of denticles placed laterally, as



in the Rays, through many intermediate stages, to those having two rows placed very near together along the posterior surface; in others there is only a single row of denticles along the posterior surface; and, again, there are many examples without any denticles. These variations offer a curious parallelism to the fossil examples; and if, as I have elsewhere hinted, the genus *Compsacanthus* of Newberry, with only one row of denticles, should turn out to be a closely related genus to *Pleuracanthus*, it will be still more so. I have also recently acquired some spines with the same dense structure as the *Pleuracanthus*, and similar in form, but devoid of any denticles so far as I have ascertained, though I have not been able to get one quite clear of the matrix.

In the peculiar group of fishes *Ischyodus* the spine in some respects very much resembles the *Pleuracanthus*; it is situated immediately behind the head, is nearly straight, and has two rows of denticles situated laterally on its upper part. A large proportion of its length is without a fin-groove. Nearer its base, however, there is a cavity for the fin which extended behind the spine. Its base is expanded into a rounded articulating surface, and fits into a socket composed of a strong cartilage springing from the vertebræ—an arrangement which allows of very considerable motion, and enables the fish to elevate and depress its spine at will. The joint is similar in the main to that of the Siluroids, but is less complex and devoid of the interlocking apparatus characteristic of that group. The *Ischyodus* occurs in the Lias and Chalk formations; and though the Chimeroids offer few resemblances to either the *Pleuracanthus* or Siluroids, its spine appears to occupy, in some respects, an intermediate place between the two.

As already observed, the position of the eyes in *Pleuracanthus* has not been identified. This may be due in great measure to the parts surrounding the orbit being of a soft cartilaginous nature, and filling up the orifice previous to its fossilization; but it may also be well to remember that the eye in the Siluroid fish is very small compared with that of the Sharks or Rays, and for this reason it would be more likely to become obliterated.

There are, then, the following conspicuous points of relationship with the Siluroids:—the long tapering figure of the fish; its broad depressed head with rounded snout and terminally situated wide mouth; the naked skin, or more rarely covered with minute enamelled, rhomboidal, detached plates; the absence of scales; the peculiarities of the spine; the long unpaired fin extending along the back, encircling the straight

slender tail, and extending along the ventral surface of the body; the spinous and interspinous bones of the body, and the osseous rays of the fin; the presence of a clavicle in the shoulder-girdle; and the fact of there being branchiostegal rays with teeth attached supporting the gills. In the specimen described by Dr. Goldfuss the two anteriorly-pointing conical cavities are considered, apparently with much reason, to be the nasal cavities; and if this be so, they are of decidedly teleostean character, the nasal orifices of the Plagiostomous fishes being in all cases situated beneath the snout and in the Chimera and Rays close to the angles of the mouth, the mouth and nasal orifice in some instances being connected by a groove.

From a consideration of the peculiarities existing in the fishes composing the genus *Pleuracanthus* we are led to the conclusion that it claims a nearer relationship with the bony fishes than with the Elasmobranchs, though there is equal reason to believe that it possesses many characters in common with the Sharks and Rays. We are therefore further led to place the genus in an intermediate position between the two. The distinguishing characters used in modern classification to distinguish the Sharks and Ganoids, viz. the many-valved muscularly-contracting bulbus arteriosus, the spiral valve of the intestine, and the chiasma of the optic nerves, are of such a perishable nature that they are not likely to be found in fossil fishes. In the absence of these we are driven to select such characters for classification as may be preserved, and to collate them as best we may with those of existing forms. Prof. Huxley, in the tenth decade of the Geological Survey, has pointed out the seeming relationship between some of the Ganoid fishes (so called) of the Old Red Sandstone and the modern Siluroids. In the structure of the head of *Coccosteus* the general arrangement of the bony exoskeleton much resembles that of the tropical fish *Clarias*; whilst the peculiar form of the mandibles, and the expansion of the bony elements usually considered to be homologous with the coracoid and radius of other fishes so as to form a large ventral shield, offer many points of resemblance to the Siluroid *Loricaria*. The Devonian *Pterichthys* is also in several ways closely related to the modern Siluroids; its osseous envelope can only be compared to the box-like cincture of the modern *Ostracion*; and the fossil fish *Cephalaspis* has also certain resemblances to *Callichthys* and *Loricaria*. Prof. Huxley remarks, "At any rate, I think the *primâ facie* case in favour of the Teleostean nature of *Coccosteus* is so strong that

it can no longer be justifiable to rank it among the Ganoids 'sans phrase,' but that even those who will not allow it to be a Teleostean must attach to it the warning adjunct of *incertæ sedis*." And further, "Why should not a few Teleosteans have represented their order among the predominant Ganoids of the Devonian epoch, just as a few Ganoids remain among the predominant Teleosteans of the present day? When it is considered that an ichthyologist might be acquainted with every freshwater and marine fish of Europe, Asia, South Africa, South America, the Indian Archipelago, Polynesia, and Australia, and yet know of only one Ganoid, the sturgeon (a fish so unlike the majority of its congeners that a naturalist might be well acquainted with almost all the fossil Ganoids and yet not recognize a sturgeon as a member of the group), it will not seem difficult to admit the existence of a Teleostean among the Devonian Ganoids, even though that Teleostean should in some, even important, points differ from those with which we are familiar."

The relationship of the peculiar fishes of the Old Red Sandstone to the Siluroids of the present time, so clearly enunciated by Prof. Huxley, and, so far as can be defined with our present limited knowledge, with every appearance of probability and truth, carries back the advent of Teleostean fishes to the earliest geological periods during which fishes are known to have existed. Along with the Ganoids they have the greatest claim to antiquity of all the fishes whose remains have been identified. It is possible that the two groups may have had much in common, and that a common ancestry in some intermediate form may be discovered in still older rocks. In the fishes from the Coal-measures, which form the subject of this communication, there seems to be something very like a bridge, a transitional form between the then predominant Elasmobranchs and the Siluroid Teleosteans. Its affinities appear to be decidedly on the side of the Siluroids; and it may best be considered as a forerunner of that great group of fishes. In geological time *Pleuracanthus* is known to extend from the Lower Coal-measures, through the Middle and Upper Coal-measures, of England and America, occurring in the gas-coals of Bohemia (regarded as intermediate or passage-beds between the Carboniferous and Permian rocks), and up into marl slates of the latter group. It remains to be seen what were the successive steps in development which have resulted in the completely ossified and highly organized Siluroids now existing.



TABLE VI. (continued).

	Wales &c.		Hartfell Shale.		Girvan.			Scania &c.		N.E. America.		
	Conway.	Salop.	Lower.		Up.							
			Cyngbordy.	C. Wilsoni Zone.	D.-Clingani Zone.	P.-linearis Zone.	D.-complanatus Zone.					
<i>Diplograptus foliaceus</i> , <i>Murch.</i> . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>quadrimucronatus</i> , <i>Hall</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>perexcavatus</i> , <i>Lapw.</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>socialis</i> , <i>Lapw.</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>rugosus</i> , <i>Enmons</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>putillus</i> , <i>Hall</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>truncatus</i> , <i>Lapw.</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>pristis</i> , <i>His.</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>hudsonicus</i> , <i>Nich.</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
<i>Cryptograptus tricornis</i> , <i>Carr.</i> . . . .	*	*	*	*	*	*	*	*	*	*	*	*
LASIOGRAPTIDÆ.												
<i>Lasiograptus Harknessi</i> , <i>Nich.</i> . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— <i>margaritatus</i> , <i>Lapw.</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
<i>Glossograptus Hincksi</i> , <i>Hopk.</i> . . . .	*	*	*	*	*	*	*	*	*	*	*	*
RETIOLITIDÆ.												
<i>Retiolites fibratus</i> , <i>Lapw.</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*
— ? <i>eucharis</i> , <i>Hall</i> . . . . .	*	*	*	*	*	*	*	*	*	*	*	*

A cursory examination of the Table given above is sufficient to convince those who accept the data already brought forward of the total distinctness in palæontological features between the Graptolite faunas of the Bala and the Arenig. In the true Bala beds here cited not a single example of the families of the *Dichograptidæ* or *Phyllograptidæ* has hitherto been detected. So far as our present information enables us to judge, they appear to have become wholly extinct; and their place is occupied by the very distinct families of the *Diplograptidæ* and *Dicranograptidæ*. The *Diplograptidæ*, so feebly represented in the Arenig and Lower-Llandeilo rocks, are now the dominant forms. In every zone they occur in swarms, and of the two genera *Diplograptus* and *Climacograptus* it is doubtful which is the more prolific. The old genus *Cryptograptus*, however, which is by no means rare in the highest Arenig, and the individuals of which teem in the

Llandeilo-Glenkiln beds, here suddenly expires, almost upon the threshold of the Caradoc formation. The *Dicranograptidæ* and the allied group of the *Leptograptidæ* have here their point of culmination and extinction. In point of numerical abundance these two families almost divide the palm with the *Diplograptidæ* on several horizons in this formation; but, unlike the members of that family, not a single example of either seems to have outlived its highest zones.

*Lower Caradoc (Hartfell).*—The typical graptolitiferous deposit of this age is undoubtedly the Hartfell shales of the south of Scotland; and to the physical and palæontological scale there exhibited the extra-Scottish Graptolite-bearing Bala deposits must in the meantime be referred.

In the lower division of the Hartfell shales we recognize three successive zones, of which the lowest may be regarded as intermediate in its palæontological characters between the typical Glenkiln and Hartfell groups. To this transitional zone the majority of the forms common to the Glenkiln and Caradoc strata are as yet restricted. The zone has not yet been certainly detected outside the range of the Moffat shales, except perhaps in Girvan, where it is imbedded in strata full of Bala-Caradoc Crustacea.

The central (*Dicranograptus-Clingani*) zone of the Lower Hartfell is the most characteristic band, and is recognizable not only in the Moffat region, but also in Wales, Ireland, and Sweden, and it is, I suspect, no great distance below the typical Bala Limestone itself.

The highest (*Pleurograptus-linearis*) zone is remarkable for the extraordinary number of *Leptograptidæ* which it contains. This little family culminates upon this horizon, members of its dubiously distinct genera *Leptograptus*, *Amphigraptus*, and *Pleurograptus* occurring in crowds.

The genus *Dicranograptus*, Hall, is by no means uncommon in the Lower Hartfell beds generally; but it hardly appears to survive into the highest zone, above which it is wholly unknown. The well-known species *Dicranograptus ramosus* is almost worldwide in its geographical range; and so, in all probability, is the intimately allied *D. Nicholsoni*, Hopk.

The genus *Dicellograptus*, however, is the most predominant bifid form. Few of its species have a long range within the formation; and only three, viz. *Dicellograptus Forchhammeri*, Gein., *D. elegans*, Carr., and *D. Morrisi*, Hopk., are as yet known outside the limits of the south of Scotland.

*Leptograptus flaccidus*, Hall, ranges from the Glenkiln into the top of the Lower Hartfell, where it seems to expire with

the inconstant pseudo-genera that complete its special division of the family.

The numerous *Diplograptidæ* present are generally of long range; but *Climacograptus Scharenbergi*, Lapw., *Diplograptus euglyphus*, Lapw., *D. rugosus*, Emmons, and *D. perexcavatus*, Lapw., belong to the lower zones only, and *D. quadrimucronatus*, Hall, and *Climacograptus tubuliferus*, Lapw., are restricted to the upper beds.

Of the *Lasiograptidæ* we here seem to meet with the last survivors. *Lasiograptus Harknessi* is found in the lower strata, and *L. margaritatus*, Lapw., in the middle. The former is accompanied by the latest known forms of *Glossograptus*. Of new forms the most remarkable are the forerunners of the true *Retiolites* with its superficial network, here represented by the strange forms *Retiolites fibratus*, Lapw., and *R. ? eucharis* of Hall.

*Upper Caradoc* (Hartfell).—In the Moffat area these strata are comparatively barren, and the known fossils are restricted as yet to two zones, one near the base of their subformation, the other at its summit. The former, which is seen as a narrow black seam in the "Barren Mudstones" of the shales, is crowded with a peculiar species of *Dicellograptus* (*D. complanatus*, Lapw.) and a few forms of *Diplograptidæ*. Scanty as are the fossils of this zone, its beds are easily identified thereby in Girvan, in Ireland, and even in Scandinavia, where they aid us in fixing the *Trinucleus*-shales of Southern Sweden as being of true Upper Bala age.

The second zone, that of *Dicellograptus anceps*, has even a scantier fauna, consisting as yet merely of the forms *D. anceps*, Nich., *Diplograptus truncatus*, Lapw., *Climacograptus bicornis*, Hall, and *C. scalaris*, His., var.; which, however, reappear unmodified in the Drummuck beds at the summit of the Bala of Girvan, and are also present in the *Trinucleus*-beds of Sweden.

The mortality in families, genera, and species of *Rhabdophora* in the Upper Caradoc beds is extraordinary. The entire families of the *Dicranograptidæ*, *Leptograptidæ*, and *Lasiograptidæ* disappear from sight altogether. The only families that survive into the Llandovery are those of the *Diplograptidæ* and *Retiolitidæ*, and these only in a very degenerate form. With the exception of a doubtful variety of the conventional species *Climacograptus scalaris* of Hisinger, not a single form found in the Bala rocks has hitherto been met with in strata of Llandovery age; so that, as far as the *Rhabdophora* are concerned, the palæontological break between the Ordovician and Silurian systems seems to be complete.

SILURIAN SYSTEM (*Upper Silurian of Murchison*).*Valentian or Llandovery-Tarannon Formation.*

TABLE VII. Showing the Range of the Lower (and Middle) Valentian Rhabdophora.

	(C)	(C)	(C)	(C)	(A)	(B)	(C)	(C)	(A)	(B, C)	(A, B)	(A-C)	(B, C)	(B)	(B, C)	(A-C)	(C)
	Machynlleth.	Cefn Symlog.	<i>M. tenuis</i> Zone.	<i>M. argenteus</i> Zone.	<i>D. acuminatus</i> &c.	<i>M. gregarius</i> Zone.	<i>M. Sedgwicki</i> Zone.	<i>R. maximus</i> Zone.	Mullock-Hill Beds.	Saugh-Hill Shales.	Coalpit-Bay Beds.	Upper Pomeroy Beds.	<i>M. lobiferus</i> Zone, Scania.	<i>M. lobiferus</i> Zone, Westrog.	Kallholn Schist, Dalarne.	Thuringia, Germany.	Bohemia.
<b>MONOGRAPTIDÆ.</b>																	
<i>Rastrites capillaris</i> , Carr. ....	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
— <i>distans</i> , Lapw. ....	.	.	.	*	.	.	.	*	.	.	.	.	.	.	.	.	Ee 1.
— <i>fugax</i> , Barr. ....	.	.	.	.	.	.	*	*	.	.	*	.	.	.	.	.	Ee 1.
— <i>gemmatus</i> , Barr. ....	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.
— <i>Linnæi</i> , Barr. ....	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.
— <i>maximus</i> , Carr. ....	*	.	.	*	.	.	.	*	.	.	.	.	.	.	.	.	Col.,
— <i>peregrinus</i> , Barr. ....	*	*	*	*	.	*	*	*	*	*	*	*	*	*	*	*	Ee 1.
— <i>urceolus</i> , Richter. ....	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Monograptus argenteus</i> , Nich. ...	.	.	.	*	.	.	.	*	.	.	.	.	.	.	.	*	.
— <i>argutus</i> , Lapw. ....	.	.	*	*	.	*	*	*	.	*	*	.	*	.	.	.	Col.
— <i>attenuatus</i> , Hopk. ....	.	.	.	*	*	*	*	*	.	*	*	*	*	*	.	.	.
— <i>Becki</i> , Barr. ....	.	.	.	*	.	*	*	*	.	*	*	.	*	.	*	*	.
— <i>Clingani</i> , Carr. ....	.	*	.	.	.	*	*	*	.	*	*	.	*	.	.	.	.
— <i>concinnus</i> , Lapw. ....	.	.	.	.	.	*	*	*	.	*	*	.	*	.	.	.	.
— <i>crassus</i> , Lapw. ....	.	.	.	.	.	*	*	*	.	*	*	.	*	.	.	.	.
— <i>crenularis</i> , Lapw. ....	.	*	.	.	.	*	*	*	.	*	*	.	*	.	.	.	.
— <i>cyphus</i> , Lapw. ....	.	*	*	.	.	*	*	*	.	*	*	*	*	*	.	.	.
— <i>fimbriatus</i> , Nich. ....	.	.	*	*	.	*	*	*	.	*	*	*	*	*	.	.	.
— <i>galaensis</i> , Lapw. ....	.	.	.	.	.	*	*	*	.	*	*	.	*	.	.	.	.
— <i>gregarius</i> , Lapw. ....	*	*	*	*	.	*	*	*	.	*	*	*	*	*	*	*	.
— <i>Hisingeri</i> , Carr. ....	*	*	.	.	.	.	.	.	.	*	*	.	*	*	*	*	Col.

† The Rhabdophora enumerated in the first two columns of this table have been identified by myself in a collection of fossils recently obtained from the comparatively barren Silurian strata of Cardiganshire (the Lower Llandovery of the Survey publications) by Professor Keeping, who has generously permitted me to anticipate here the publication of this most important discovery. To the Graptolithologist this list is, indeed, most valuable; for no Rhabdophora have hitherto been quoted from the undisputed Llandovery strata of Wales.



TABLE VII. (continued).

	(C)	Machynlleth.	Cardigan.
	(C)	Cefn Symlog.	
	(C)	M.-tenuis Zone.	Conistone Mudstone.
	(C)	M.-argenteus Zone.	
	(A)	D. acuminatus &c.	
	(B)	M.-gregarius Zone.	Birchill Shales.
	(C)	M.-Sedgwicki Zone.	
	(C)	R.-marinus Zone.	
	(A)	Mullock-Hill Beds.	Girvan.
	(B, C)	Saugh-Hill Shales.	
	(A, B)	Coalpit-Bay Beds.	
	(A-C)	Upper Pomeroy Beds.	Ireland.
	(B, C)	M.-lobiferus Zone, Scania.	
	(B)	M.-lobiferus Zone, Westrog.	Sweden.
	(B, C)	Kallholn Schist, Dalarne.	
	(A-C)	Thuringia, Germany.	
	(C)	Bohemia.	
Monograptus intermedius, Carr. . . . .	*	*	
— leptotheca, Lapw. . . . .	*	*	
— lobiferus, M <sup>c</sup> Coy . . . . .	*	*	
— proteus?, Barr. . . . .	*	*	
— runcinatus, Lapw. . . . .	*	*	
— Sandersoni, Lapw. . . . .	*	*	
— Sedgwicki, Portl. . . . .	*	*	
— spiralis, His. . . . .	*	*	
— Salteri, Lapw. . . . .	*	*	
— turriculatus, Barr. . . . .	*	*	
— tenuis, Portl. . . . .	*	*	
— triangulatus, Harkn. . . . .	*	*	
DIPLOGRAPTIDÆ.			
Diplograptus (Dimorphograptus) elongatus, Lapw. . . . .	*	*	
— (—) Swanstoni, Lapw. . . . .	*	*	
— acuminatus, Nich. . . . .	*	*	
— confertus, Nich. . . . .	*	*	
— folium, His. . . . .	*	*	
— Hughesi, Nich. . . . .	*	*	
— insectiformis, Nich. . . . .	*	*	
— modestus, Lapw. . . . .	*	*	
— palmeus, Barr. . . . .	*	*	
— physophora, Nich. . . . .	*	*	
— sinuatus, Nich. . . . .	*	*	
— vesiculosus, Nich. . . . .	*	*	
Cephalograptus cometa, Gein. . . . .	*	*	
Climacograptus normalis, Lapw., var. . . . .	*	*	
— tectus, Barr., var. . . . .	*	*	
— rectangularis, M <sup>c</sup> Coy, var. . . . .	*	*	
— innotatus, Nich. . . . .	*	*	
RETIOLITIDÆ.			
Retiolites perlatus, Nich. . . . .	*	*	
— Daironi?, var., Lapw. . . . .	*	*	
			E e l.
			Col.
			E e l.
			E e l.
			Col., E e l.
			E e l.
			Col.

This fauna reminds us at once of that of the Arenig formation in the extraordinary predominance of a single family of the Rhabdophora. The Monograptidæ, of which a few scattered examples are found for the first time in some of the lowest Llandovery beds, multiply so rapidly that long before we reach the middle beds of the Valentian formation they have become the dominant family. For a time the Diplograptidæ hold their own, as if contesting every horizon; but at the very commencement of the Tarannon period the issue is practically decided. One by one the species of the Diplograptidæ sink out of sight; and when the true Wenlock is reached the last has vanished. A Retiolite form occurs alone for some time longer; but in the Lower Ludlow the *Monograptus* reigns unchallenged, the solitary survivor of its race.

As in the case of the Glenkiln and Caradoc formations, we turn to the south of Scotland for our typical Graptolite-bearing rocks of Valentian age, where they compose the Birkhill shales and the overlying Gala group. These strata have been so minutely searched for Rhabdophora that there seems to be an uninterrupted zoological gradation from the base to the summit of the formation. In the entire series we seem at present to recognize five subgroups of tolerably equal systematic importance—the (1) Lower, (2) Middle, and (3) Upper Birkhill shales, and (4) (5) the Gala and Grieston groups. Of these, nos. 1, 2, and 3 are possibly included in the so-called Lower Llandovery formation of South Wales, while the fourth and fifth correspond to the Upper Llandovery and Tarannon.

(A) *Lower Birkhill*.—This includes the so-called zones of *Diplograptus acuminatus*, Nich., and *D. vesiculosus* of Dobbs Linn &c., and contains but few Graptolites in addition to those which give their names to the zones. *M. tenuis*, Portlock, and *M. attenuatus*, Hopk., are its only Monograptidæ, and are the first species of this family hitherto detected. The remaining fossils are Diplograptidæ of extended range.

(B) *Middle Birkhill*.—This division, which embraces the thick zone of *Monograptus gregarius*, Lapw., is most prolific in Rhabdophora, and is recognizable not only in the Moffat area, but also in Girvan, Ireland, and Sweden. In this zone the Diplograptidæ and Monograptidæ are tolerably equal in species and individuals. The species *D. vesiculosus*, Nich., and *D. physophora*, Nich., make here their final appearance. The genus *Rastrites* (Barr.) occurs for the first time; and the single species *Rastrites peregrinus* is remarkably prolific. Of the genus *Monograptus* species are abundant, but few are peculiar. Among the latter is the transitional form *M. triangularatus*, Harkn.

(C) *Upper Birkhill*.—This division, the most varied in its mineralogical character and its included species, has also the widest geographical extension. To it belong the graptoliferous shales of the so-called Lower Llandovery of Cardigan, recently examined by Prof. Keeping, and also the disputed graptolitic mudstones of the Coniston area of Westmoreland. Elsewhere its representatives are recognizable in Girvan, County Down, in the typical *Lobiferus*-beds of Scania, in the Alaunschiefer of Germany, and in the Colonies and the band *Eel* of Bohemia.

In all these widely separated regions the fauna is most distinctly of the type of that of the Upper Birkhill shales. In this group, in the typical localities near Moffat, we recognize three fairly distinct zones, the lowest characterized by *Cephalograptus cometa*, Geinitz, and some survivals from the underlying *M.-gregarius* zone—and the upper distinguished by *Rastrites maximus*, Carr., and by a few species which become much more abundant in the overlying Gala beds.

Generally speaking, these Upper Birkhill beds, in the whole of their range from Cardigan through Northern and Central Europe, are particularized by the preponderance of Monograptidæ of the genera *Rastrites* and *Monograptus* (both of which probably attain their specific maximum upon this horizon), and by the exclusive presence of such forms as *Monograptus Hisingeri*, Carr. (*jaculum*), *M. intermedius*, Carr., *M. crenularis*, Lapw., and Diplograptidæ of the type of *Diplograptus Hughesi*, Nich., *Cephalograptus cometa*, Geinitz, &c.

A few of the commonest forms pass onwards into the strata of the succeeding Upper Valentian or Tarannon group. Of these the chief are *Climacograptus normalis*, Lapw., *Diplograptus palmeus*, Barr., *D. folium*, His., and some forms of *Monograptus Sedgwickii*, Portl.

#### *Gala or Tarannon Group.*

Mineralogically the distinction between the Gala group and the underlying Birkhill series is most marked; but palæontologically there is an insensible gradation from the one into the other. The Birkhill beds consist of black shales of no great vertical extent, while the Gala series is formed of grey conglomerates, flagstones, and shales of enormous collective thickness. It is more than doubtful, however, if the Gala group at all approaches the Birkhill beds in systematic importance. It must be looked upon at present as a transitional formation—its lower beds graduating zoologically into the inferior Birkhill beds, and its higher zones passing insensibly

TABLE VIII. Showing the Range of the Gala-Tarannon Rhabdophora.

	Tarannon Sh., Conway B., N. Wales.	Gala Group (A).	South-east Scotland.	Girvan.	Sweden.	Bohemia.	Clinton Beds, N.E. America.
<b>MONOGRAPTIDÆ.</b>							
Rastrites distans, <i>Lapw.</i> . . . . .	*	*					
— Linnæi, <i>Barr.</i> . . . . .	*	*					
— fugax, <i>Barr.</i> . . . . .	*	*					
— maximus, <i>Barr.</i> . . . . .	*	*					
Monograptus Becki, <i>Barr.</i> . . . . .	*	*					
— Barrandei, <i>Suess?</i> . . . . .	*	*					
— bohemicus†, <i>Barr.</i> . . . . .	*	*					
— clintonensis, <i>Hall</i> . . . . .	*	*					*
— colonus, <i>Barr.</i> . . . . .	*	*					
— concinnus, <i>Lapw.</i> . . . . .	*	*					
— crassus, <i>Lapw.</i> . . . . .	*	*					
— crispus, <i>Lapw.</i> . . . . .	*	*			*		
— exiguus, <i>Nich.</i> . . . . .	*	*			*		
— Flemingii, <i>Salt.</i> . . . . .	*	*			*		
— galaensis, <i>Lapw.</i> . . . . .	*	*			*		
— Hisingeri, <i>Carr.</i> . . . . .	*	*			*		
— leptotheca, <i>Lapw.</i> . . . . .	*	*			*		
— lobiferus, <i>M'Coy</i> . . . . .	*	*			*		
— Nilssoni, <i>Barr.</i> . . . . .	*	*			*	*	
— nuntius, <i>Barr.</i> . . . . .	*	*			*	*	
— priodon, <i>Bronn</i> . . . . .	*	*			*	*	*
— proteus, <i>Barr.</i> . . . . .	*	*			*	*	
— riccartonensis, <i>Lapw.</i> . . . . .	*	*			*	*	
— runcinatus, <i>Lapw.</i> . . . . .	*	*			*	*	
— Salteri, <i>Lapw.</i> . . . . .	*	*			*	*	
— Sedgwicki, <i>Portl.</i> . . . . .	*	*			*	*	
— spiralis, <i>Geinitz</i> . . . . .	*	*			*	*	
— turriculatus, <i>Barr.</i> . . . . .	*	*			*	*	
— Ræmeri, <i>Barr.</i> . . . . .	*	*			*	*	*
— vomerinus, <i>Nich.</i> . . . . .	*	*			*	*	
Cyrtograptus Grayæ, <i>Lapw.</i> . . . .	*	*			*	*	
<b>DIPLOGRAPTIDÆ.</b>							
Diplograptus folium, <i>His.</i> . . . .	*	*			*	*	
— palmeus, <i>Barr.</i> . . . . .	*	*			*	*	
— tamariscus, <i>Nich.</i> . . . . .	*	*			*	*	
Climacograptus normalis, <i>Lpw.</i> , var. .	*	*			*	*	
— tectus, <i>Barr.</i> , var. . . . .	*	*			*	*	
Retiolites Geinitzianus, <i>Barr.</i> . . .	*	*			*	*	
— obesus, <i>Lapw.</i> , var. . . . .	*	*			*	*	
— venosus, <i>Hall</i> . . . . .	*	*			*	*	*

† The species printed in italics in this table do not occur upon these horizons in Britain, and are possibly erroneously identified from the corresponding European zones.

upwards into the Riccarton Flags, which are the South-Scottish equivalents of the Wenlock beds of Siluria.

This also appears to be the general zoological character of the Tarannon shale of Wales and the north of England, which occupies the systematic place of the Gala group, to which, however, it is vastly inferior in vertical thickness and in the richness and variety of its Graptolite fauna.

In the Gala beds of the south of Scotland we recognize at present two main divisions. In the Lower Gala alone do we meet with the survivals from the Birkhill fauna; but these are here associated with the typical Gala species, *Monograptus exiguus*, Nich., *M. galaensis*, Lapw.—together with *M. priodon*, Bronn, which ranges upwards from this horizon into the Wenlock shale. In the Upper Gala the fauna gives many indications of the gradual change into that of the Salopian type—*Retiolites Geinitzianus*, Barr., *Monograptus riccartonensis*, and other Wenlock forms being frequently met with. Here we meet for the first time with the genus *Cyrto-graptus* of Carruthers. The genus *Rastrites*, however, is already extinct; and all the Diplograptidæ have disappeared, with the exception of an occasional form in the basal beds, minute and hardly capable of specific identification.

The graptoliferous Tarannon shales of Conway yield a fauna corresponding to that of the earlier portion of the Gala beds; and the few forms hitherto collected from the Gala shales (Knock beds) of Westmoreland and the Tieveshilly shales of North-eastern Ireland afford unmistakable indications of the presence in these localities of a corresponding assemblage of forms.

The predominant and characteristic fossil of the Lower Gala subformation is *Monograptus exiguus*, Nich., which is as yet unknown outside the limits of the Lower Gala-Tarannon series.

#### *Salopian or Wenlock-Ludlow Formation.*

In the Valentian or Llandovery-Tarannon formation, as we have seen, the Diplograptidæ, so prevalent in its earlier strata, succumb before the swift increase of the Monograptidæ, till finally in the highest Tarannon beds they have dwindled away to an occasional diminutive form of *Diplograptus* only. In the overlying Salopian beds even these degenerate forms appear to be wanting; and in the lower divisions of the Wenlock shales of Britain the numerous Monograptidæ are accompanied only by the single diprionidian species *Retiolites Geinitzianus*, Barr. This, again, is unknown in the highest beds of the

TABLE IX. Showing the Range of the Salopian Rhabdophora.

	Zone of <i>Cyrtograptus Murchisoni</i> .			Wenlock Shales.						Lower Ludlow.	
	Britain.		Retiolites-Beds, Scania.	Wales.		Scotland.		Norway.	Zone of <i>M. testis</i> &c., Scania.	Neffiez, France.	E 2, Bohemia.
	Builth.	N. Wales.		Builth.	N. Wales.	Lake District.	Riccarton Beds.				
		Lake District.					Pentland Hills.				
<b>MONOGRAPTIDÆ.</b>											
<i>Monograptus bohemicus</i> , Barr. . .	.	.	.	.	.	.	.	.	.	.	.
— <i>chimæra</i> , Barr. . . . .	.	.	.	.	.	.	.	.	.	.	.
— <i>Flemingii</i> , Salt. . . . .	.	.	.	.	.	.	.	.	.	.	.
— <i>colonus</i> , Barr. (?) . . . . .	..	..	..	..	..	..	..	..	..	..	..
— <i>basilicus</i> , Lapw. . . . .	*	*	*	*	*	*	..	*	*	*	*
— <i>leintwardinensis</i> , Hopk. . . . .	.	.	.	.	.	.	.	.	.	.	.
— <i>M'Coyii</i> , Lapw. . . . .	.	.	.	.	.	*	.	.	.	.	.
— <i>Nilssoni</i> , Barr. . . . .	.	.	.	.	.	.	.	.	.	.	.
— <i>nudus</i> , Lapw., var. . . . .	.	.	*	*	.	.	*	.	..	.	.
— <i>minor</i> , M'Coy . . . . .	.	.	*	*	.	.	*	.	.	.	.
— <i>priodon</i> , Brown . . . . .	*	*	*	*	*	*	*	*	*	*	*
— <i>Rœmeri</i> , Barr. . . . .	.	.	.	..	.	.	.	.	.	*	.
— <i>Salweyi</i> , Hopk. . . . .	.	.	.	.	.	.	.	.	.	*	.
— <i>scanicus</i> , Tullb. . . . .	.	.	.	.	.	.	.	.	.	.	.
— <i>vomerinus</i> , Nich. . . . .	*	*	*	*	*	*	*	*	*	.	.
— <i>riccartonensis</i> , Lapw. . . . .	*	*	*	*	.	.	*	.	*	.	.
— <i>testis</i> , Barr. . . . .	.	.	.	.	.	.	.	.	*	.	.
<i>Cyrtograptus Carruthersi</i> , Lapw. . . . .	.	.	.	.	.	*	*	..	.	.	.
— <i>Linnarssoni</i> , Lapw. . . . .	.	.	.	*	.	.	.	.	.	.	.
— <i>Murchisoni</i> , Carr. . . . .	*	*	*	.	.	.	.	.	.	.	.
<b>RETIOLITIDÆ.</b>											
<i>Retiolites Geinitzianus</i> , Barr. . .	*	*	*	.	.	.	..	*	.	.	.

Wenlock, or in the so-called Lower Ludlow shales, where *Monograptidæ* alone have hitherto been detected. The members of this family are tolerably abundant in the lower zones of the Wenlock; but specifically they are far less numerous than in the populous Birkhill shales of the Lower-Valentian era. In the Lower Ludlow, *Monograptidæ* are not uncommon upon certain horizons; but the species are few and of few types. Above this subformation the sandy strata of the Downtonian formation suddenly set in; and beyond the occa-

sional recognition of a fragmentary specimen of *Rhabdophora* in these deposits incapable of specific identification, nothing is known of their further existence.

In the great mudstone series of the Salopian of Siluria, at least two fairly distinct zones are at present recognizable. The base of the Wenlock from Llangadock to Bala and Glyn Ceriog, as well as in the Lake district itself, is formed by a series of dark shales and flags marked by the presence of *Cyrtograptus Murchisoni*, Carr. It is accompanied by the other forms enumerated under this head in the accompanying Table, some being survivals from the Tarannon fauna, and others strictly peculiar to the Wenlock shales. The same zone is recognizable in Scania, occupying a similar stratigraphical place and yielding a corresponding Graptolite fauna.

In the main mass of the Wenlock shales *Cyrtograptus Linnarssoni*, Lapw., is the most conspicuous form near Builth. Of the fossils peculiar to higher horizons we as yet know little; but it may be expected that we shall in the future meet here with the zone of *M. testis*, Barrande, which has hitherto remained undiscovered in Britain, but has a wide geographical range on the European continent.

The most abundant forms of Wenlock age in Britain are:—*M. vomerinus*, Nich., which is ubiquitous in its distribution; *M. riccartonensis*, a most prolific Scotch species; and *M. priodon*, Bronn, which does not appear to survive into the later strata of the Lower Ludlow.

#### *Lower Ludlow Beds.*

It is certain that we have yet much to learn with respect to the *Rhabdophora* of the Upper Wenlock beds; for none of the forms enumerated above appear to survive into the Lower Ludlow formation. In certain localities, however, these Lower Ludlow beds are prolific in Graptolites, especially *M. Salweyi*, Hopk., *M. leintwardinensis*, Hopk., *M. Nilssoni*, Barr., *M. bohemicus*, Barr., *M. scanicus*, Tullberg, many of which are present also in the highest zones of the graptoliferous rocks of Scania and in corresponding strata in Bohemia and France.

[To be continued.]

XXXV.—*On a Collection of Crustacea from the Malaysian Region*.—Part III. *Crustacea Anomura and Macrura (except Penæidea)*. By EDWARD J. MIERS, F.L.S., F.Z.S.

[Continued from p. 317.]

# ANOMURA.

## DROMIIDEA.

### *Dromia vulgaris*, M.-Edw.

A fine adult male is in the collection (without definite locality) which does not seem to differ specifically from the Mediterranean *D. vulgaris*. The tubercle or accessory tooth at the base of the second antero-lateral marginal tooth, however, is more developed than is usually the case in *D. vulgaris*. A specimen undoubtedly belonging to *D. vulgaris* is in the Museum collection from Gen. Hardwicke, and therefore presumably from the Indian Ocean.

### *Dromia Rumphii*, Fabr., junior?

I refer, with some hesitation, to this species a female *Dromia* which differs from adult examples of *D. Rumphii* in the proportionally narrower, more elongated carapace, the front and sides of which slope much more steeply (almost vertically) to the rostrum and antero-lateral margins. The carapace is much more convex anteriorly and is covered with a much shorter, more scanty pubescence. The median tooth of the rostrum is nearly obsolete; and the fifth pair of legs is relatively more elongated. The exact locality of this specimen has not been preserved. Length 1 inch 7 lines, breadth nearly 1 inch 9 lines.

I have observed very similar differences between adult *D. vulgaris* and a series of young *Dromiæ* from Sardinia in the Museum collection.

### *Dromia (Dromidia) orientalis*, sp. n.

(Pl. XV. figs. 1, 2.)

Carapace convex, but little broader than long, and covered with a close velvety pubescence, which (probably through abrasion) is thin or absent on the gastric and cardiac regions; the sides slope very steeply, almost perpendicularly, to the antero-lateral margins. No sutures are visible on the upper surface. Front quinquedentate (the supraocular tooth included), the median tooth smallest, the others rather promi-



nent and tuberculiform; extraorbital tooth obsolete, infra-ocular similar to the supraocular tooth. Antero-lateral margins 6-toothed; the teeth rather small and tuberculiform; the two anterior somewhat approximated and placed at some distance behind the orbits; the two next teeth are similarly approximated, and placed near the fifth tooth. No spines on the subhepatic and pterygostomian regions; a low tubercle at the antero-lateral angles of the buccal cavity. The legs are closely pubescent; the anterior legs (in the female) rather robust, there are two tubercles on the outer surface of the carpus, and the calcareous dactyli are regularly and evenly toothed on their inner margins. The antepenultimate joints of the second and third legs are somewhat dilated distally; the fourth and fifth legs present nothing remarkable. The sternal sulci (in the female) are approximated, and terminate in a strong tubercle situated in the space between the first and second legs. The ridge on the endostome or palate is partially interrupted. Length 2 inches 4 lines, breadth 2 inches 6 lines.

Indo-Malayan Seas (a female without definite locality).

From the *Dromia Rumphii* of Fabricius, to which it has much external resemblance, this species is distinguished by the form of the sternal sulci in the female, and by the disposition of the teeth of the antero-lateral margins; the latter character also serves to distinguish it from all the species referred by Stimpson to the genus (or subgenus) *Dromidia*.

#### PAGURIDEA.

##### *Birgus latro* (Linn.).

Malaysia (an adult male of large size).

##### *Cænobita clypeata* (Fabr.).

Amboina (an adult male). The larger hand is nearly of the form figured by Dana as characteristic of the variety he designates *brevimana*, but is tuberculate externally, as in the form he considers to be the typical *clypeata*.

##### *Cænobita compressa*?

*Cænobita compressa*, Milne-Edwards, Hist. Nat. Crust. ii. p. 241 (1837);  
? De Haan, Faun. Japon. Crust. p. 213 (1849).

*Cænobita Olivieri*, Owen, Zool. Voy. 'Blossom,' Crust. p. 84 (1839);  
? Dana, U.S. Expl. Exp. xiii. Cr. i. p. 470 (1852).

*Cænobita cavipes*, Stimpson, Proc. Ac. Nat. Sci. Phil. p. 245 (1858).

? *Cænobita violascens*, Heller, Reise der Novara, Cr. p. 82, pl. vii. fig. 1 (1865).

Java (an adult male, in shell of *Pyrula*) ; Borneo, Bandjermasin (adult and two young, in shells of *Auricula* and *Purpura*) ; Batjan (adult and two smaller females, in shells of *Auricula*, *Pyrarus*, and *Murex*).

Whether these specimens belong to the *C. compressa* of Milne-Edwards is difficult to determine from his very short description ; but they appear to be referable to that species as characterized by De Haan, to the *C. Olivieri* of Owen as described by Dana, and to *C. cavipes* of Stimpson, although each of the above-cited authors lays especial stress upon different characters. Stimpson says that *C. cavipes* differs from *C. compressa* in not having the branchial regions laterally inflated ; but this is a relative distinction, and I have observed a more considerable inflation of the branchial regions in some specimens than in others. The principal characteristics of this species appear to consist in the compressed eyes, which are granulated above, in the larger hand being smooth on the lower part of its outer surface, granulated on the upper part, but without the series of oblique crests of *C. rugosa*, in the penultimate joint of the left third leg being convex on its outer surface at its upper and distal end, the terminal joint scarcely longer than the preceding, naked, and flattened on its outer surface, with corneous-tipped tubercles only on its upper and inner surface (both terminal and penultimate joint being granulated on their inferior margin) ; the tarsal joint of the third right leg is subcylindrical, and the coxæ of the fifth legs not greatly produced, in the male.

This would appear to be a very common and widely ranging species.

It is of interest to note that the *Auricula* and *Pyrarus* inhabited by this hermit-crab are brackish-water shells.

*Cænobita perlata* ?, var. *affinis* (sp. n. ?).

(Pl. XIV. fig. 8.)

A young male inhabiting the shell of a species of *Nerita* is in the collection from Batjan, which is nearly allied to *C. perlata* as described by De Haan, and to *C. purpurea*, Stimpson. The carapace is very roughly but uniformly granulated above in front of the cervical suture ; the branchial regions, which have the anterior margin nearly straight, are punctulated. The larger chelipede is tuberculated on its outer surface ; the tubercles white, with dark corneous tips ; no trace of larger tubercles disposed in oblique series. The penultimate joint of the third left leg is granulated on its outer and more distinctly on its upper surface, and very distinctly granulated on its lower margin. The tarsal joint is somewhat

longer than the preceding, nearly smooth on its outer, and densely granulated and hairy on its upper and inner surfaces. The coxæ of the fifth legs in the male are greatly produced and subacute, and nearly of equal length; the left coxa has a slight rounded prominence on its outer margin. It differs principally in the form of the coxæ of the fifth legs of the male, and may prove to be a distinct species. Length of carapace nearly  $\frac{3}{4}$  inch.

*Diogenes miles* (Fabr.).

A specimen is in the collection (without definite locality) which belongs, I believe, to this species. It very nearly resembles a specimen from the Philippine Islands, which was designated by White (but never described) as *Pagurus subpilosus*, but which cannot be regarded as specifically distinct. In these specimens the penultimate and antepenultimate joints of the legs and the outer surface of the larger hand are simply granulated (in the Philippine example the granules of the hand are less numerous and crowded). In what I regard as the adult *D. miles*, the granules of the hand and penultimate and antepenultimate joints of the legs are replaced by spinules. There are in the Museum two small specimens from Dukhun (*Col. Sykes*) which probably belong to *D. miles*\*.

\* Of the genus *Diogenes* there are in the British Museum examples from Ceylon (*Holdsworth*) and Pondicherry of the species figured by Herbst as *Cancer miles*, but which is certainly not the *miles* of Fabricius, Milne-Edwards, and Dana, and which is at once distinguished by the form of the larger hand, which is granulated on its upper and lower margins and smooth on its outer surface, by the existence of a strong blunt lobe or tubercle on the inner margin of the wrist, and by the smooth non-granulated or spinulose tarsal joints of the second and third pairs of legs. This may be the *Diogenes custos* (*Pagurus custos*, Fabr.), or may require a new specific name. There is also a specimen from Shark's Bay, W. Australia, in which the short, acute, non-spinulose rostrum does not project beyond the level of the ophthalmic scales, which are subtriangulate and entire; the arm and wrist of the larger (left) chelipede are robust and coarsely granulated on their upper and external surface; the hand somewhat less coarsely granulated, except on its upper margin, very convex on its outer surface, particularly near its articulation with the wrist; lower (immobile) finger bent downward, and forming an obtuse angle with the lower margin of the palm. The dactyli of the second and third legs on the left-hand side are rather short, and scarcely exceed the penultimate joint in length; on the right-hand side they are relatively longer and curved. This species may be designated *D. granulatus*.

It is evidently nearly allied to *D. avarus* of Heller from the Nicobars, in which species, however, the left hand is externally costate, and this chelipede on the whole represented as much slenderer, and the dactyli of the second and third (left) limbs are relatively longer.

In a specimen from the "Eastern Seas" in the Museum collection,

*Pagurus punctulatus*, Olivier.

Celebes, Badjoa (a female). A larger male is in the collection, without locality, in which the coloration has disappeared.

*Pagurus pedunculatus* (Herbst).

Batjan (an adult male). A larger male, without special locality, is in the collection.

The specimens I refer here agree very well with examples named *P. pedunculatus* by White in the Museum collection. As, however, I have not had an opportunity of referring to Herbst's figure (the Museum copy of his work being imperfect), and as some recent remarks of Hilgendorf tend to throw doubt upon the correctness of White's identification, I will add that the specimens referred to *P. pedunculatus* in the Museum collection closely resemble in external appearance *P. deformis*, M.-Edwards, but may be distinguished by the hand of the larger chelipede being somewhat more closely granulated between the larger tubercles, which, as in *P. deformis*, are disposed in longitudinal series on the upper and outer surface of the palm; the mobile finger is granulated (but not carinated) on its upper and outer surface, the granules being disposed in longitudinal series; the penultimate joint of the third left leg is smooth, not carinated as in *P. deformis*; the terminal joint, however, is nearly of the same form as in that species. The dried specimens in the Museum collection from Port Jackson and Australia have the eye-peduncles marked with a very distinct white cincture, which is not visible in the Malaysian specimens, which have been long immersed in spirits. I will add that the external genital orifices of the female are very distinct in the males of *P. deformis* in the Museum collection (as noted by Hilgendorf), but not in the males of specimens of *P. pedunculatus*.

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which I will designate *D. spinulimanus*, the rostrum is acute, but does not nearly reach to the apices of the ophthalmic scales, which are arcuate externally, but not denticulated; the merus and carpus of the larger (left) chelipede are granulated externally, the carpus armed on its upper margin with about a dozen spinules; palm armed on its outer surface and upper and lower margins with spinuliform granules; mobile finger with similar spinules on its upper margin, lower deflexed but less abruptly than in *D. granulatus*; smaller chelipede with the palm covered with long fulvous hairs, tarsal joints of the second and third legs on the right side (the left are wanting) long, hairy, and smooth.

This species may be compared to *D. penicillatus*, Stimpson, but differs in the non-denticulated ophthalmic scales, shorter rostrum, the armature of the chelipedes, &c.

*Pagurus gemmatus*, M.-Edwards.

Two specimens, males, in the collection, without special indication of locality, agree almost exactly with M.-Edwards's short description; the tubercles on the crest of the tarsus of the third left leg, however, are scarcely to be described as "tubercules arrondis," but in the larger specimen resemble small bluntish spines; the larger hand, which is very broad and short, is covered externally with unequal irregularly-disposed tubercles, and its inner surface with scattered tufts of hair; the tarsal joint of the third left leg is longer than the penultimate joint, which is not canaliculated, cristate, or flattened on its outer surface.

M.-Edwards's specimens were from the "Marquesas," by which, I presume, the Oriental group otherwise designated the Mendaña Islands is intended.

*Aniculus typicus*, Dana.

Malaysia (an adult male of large size, without locality).

*Clibanarius vulgaris*, Dana.

Borneo (an adult male, in shell of *Voluta*). A smaller male, without locality, is in the collection.

These specimens agree excellently with M.-Edwards's description, except that he says "tarse court," whereas in the Museum specimens the tarsus is longer than the preceding joint. It is to be noted that in Herbst's figure of his *Cancer clibanarius* there are no indications of the longitudinal markings of the legs described by Milne-Edwards.

*Eupagurus japonicus*? (Pl. XIV. figs. 6, 7.)

*Pagurus hirtimanus*, White, List Crust. Brit. Mus. p. 60 (1847), *sine descr.*

*Eupagurus japonicus*, Stimpson, Proc. Ac. Nat. Sci. Phil. p. 250 (1858).

Carapace nearly naked, with the cervical suture strongly defined. Rostrum prominent, triangular and acute; frontal margin with a minute spinule on either side of the rostrum, and further from it than from the antero-lateral margins. Eye-peduncles slender, and shorter than the width of the frontal margin; ophthalmic scales narrow-linear, concave above, and rounded at the distal ends. Antennal scale very short. The larger (right) chelipede with the merus unarmed, smooth, and clothed with scanty hairs; carpus with short granulated lines on its outer surface, and armed above with four spinules on the upper and inner margin and two on the upper surface;

hand ovate, densely hairy on its outer surface, with the upper and lower margins, both of palm and fingers, granulated, and with a few prominent granules near the base of the palm; the inner margins of the fingers regularly toothed near the distal ends; upper finger with a large rounded tubercle near the base. Left chelipede with the carpus biserially spinulose above, and the hand and fingers hairy. Ambulatory legs smooth, the penultimate and antepenultimate joints unarmed and not externally compressed, and the tarsal joints shorter than the penultimate joint. The first postabdominal segment (in the male) with a small lobe or projection in its posterior margin on either side of the middle line, and with a slender filiform appendage on the left side only. Length of carapace about  $\frac{2}{3}$  inch (8 lines).

A male is in the collection without definite locality. White's specimen was from the Philippines, and is also a male. There is also a small female example from the Fiji Islands (Ovalau) in the collection, in which the ambulatory legs are prettily mottled with red.

The specimens before me differ from the description of *E. japonicus* in the form of the ophthalmic scales; and there is no median series of spinules on the palm; but a line of granules with difficulty discernible amid the close pubescence exists in White's typical example. If they should be distinct, White's name of *hirtimanus* will have to be adopted for them; but a comparison of the description and figure now given with Stimpson's type is needed before the question can be certainly decided.

#### *HIPPIDEA.*

##### *Remipes testudinarius*, Latr.

Celebes, Macassar (three females, one of large size); Batjan (a male and female; one of the variety *denticulatifrons*); Bali (two males); New Guinea (two males of var. *denticulatifrons*).

#### *RANINIDEA.*

##### *Ranina serrata*, Lam.

Bali (a young male).

#### MACRURA.

##### *THALASSINIDEA.*

##### *Thalassina anomala*.

*Cancer anomalus*, Herbst, Naturg. Krabben &c. iii. (Heft 4) p. 45, pl. lxii. (1803).

*Thalassina scorpionides*, Latr. Gen. Crust. & Ins. i. p. 51 (1807), nec Guérin et Milne-Edwards; Steenstrup & Lütken, Videnskabelige Meddelelser, p. 257 (1861).

*Thalassina gracilis*, Dana, U.S. Expl. Exp. xiii. Cr. i. p. 13, pl. xxxii. fig. 5 (1852), young?

Samangkabaai, Tandjong (an adult male); Borneo, Bandjermassin (an adult female).

In an old male from W. Borneo, which I am not inclined to regard as specifically distinct, the spines of the branchial and hepatic regions are much more prominent, and there are a few spines on the cardiac region. The hands are less unequal, and the larger hand is more distinctly granulated and proportionally longer; its length is more than once and a half its breadth.

Specimens presenting the characteristics of the adult are in the Museum collection from the Indian Ocean, Philippines, and Fijis. In what I consider to be the young of this species the branchial and hepatic regions and the sides of the hands are nearly smooth, and there is sometimes but a single spine on the upper margin of the arm. Specimens are in the Museum collection from Borneo, Penang, Singapore, the Indian Ocean, Philippines (designated by White *T. talpa*), and Fiji Islands.

The reference to Herbst's *C. anomalus*, given by White, I have not been able to verify, as the plate is wanting in the copy of his work in the British Museum.

In the synonymical references I have followed Steenstrup and Lütken, according to whom the *Thalassina scorpionides* of Latreille is not identical with the Chilian species referred to under the same name by Guérin and Milne-Edwards, and which Steenstrup and Lütken designate *T. chilensis*.

#### ASTACIDEA.

##### *Scyllarus Haani*.

*Scyllarus Haani*, v. Siebold in De Haan, Faun. Japon. Cr. p. 152, pl. xxxviii. fig. 1 (1849).

Aroe (Aru?) Islands (a fine adult male).

This form is distinguished from all the other *Scyllari* with which I am acquainted by the remarkable prominence of the tubercles or elevations on the gastric, cardiac, and intestinal regions, and second, third, and especially on the fourth post-abdominal segments; the Aroe-Island specimen agrees very closely with De Haan's figure in this and in all other respects. But slighter prominences occupying similar positions are observable in *S. aquinoctialis*, *S. squamosus*, and *S. Sieboldii*;

yet in the adult males in the Museum collection these are never so prominent as in *S. Haani*. *S. Haani* is also distinguished from the majority of specimens of *S. æquinoctialis* by the form of the antepenultimate joint of the antennæ, which is arcuate and dentated on its outer margin, and by the existence of strong spines on the inner margin of this and the penultimate joint; but there is a specimen from Madeira in the Museum collection which remarkably approaches *S. Haani* in these respects; and it is possible that the examination of a sufficiently large series would show that the four forms above cited are but varying conditions of one species ranging widely through both the Atlantic and Indo-Pacific regions. The bicarination of the antepenultimate joint of the second pair of legs in *S. Sieboldii* is not, I believe, a character of specific value.

From *S. latus* this species is distinguished not only by the prominent tubercles on the thorax and postabdomen, but by the different form of the terminal joint of the antennæ, the absence of distinct serrations on the outer margin of the antepenultimate joint, the more distinctly carinated legs, and the truncated form of the lateral prolongations of the second, third, and fourth postabdominal segments.

*Parribacus antarcticus* (Lund).

New Guinea (two young females).

*Thenus orientalis*, Rumph.

W. Borneo (a female).

*Palinurus* (*Panulirus*) *fasciatus* (Fabr.).

W. Borneo (a female and young male). A larger female is in the collection, without locality.

*Palinurus* (*Panulirus*) *ornatus* (Fabr.).

Indo-Malayan seas (a female, without locality).

A male and two very young individuals from Amboina perhaps belong to this species, although in them the original coloration has entirely disappeared; also a young individual, probably male, from New Guinea. In the younger individuals the external genital openings are not distinguishable; and I consider the New-Guinea specimen to be a male only on account of the uniramous appendages of the postabdominal segments. In young specimens, also, the rudimentary median spines of the rostral plate are absent. In an adult male of large size from the Pison Islands (Cape Melville) in the



Museum collection, the greenish or bluish rings on the ambulatory legs are much interrupted, so that the legs appear to be irregularly spotted or marbled rather than annulated.

*Palinurus* (*Panulirus*) *penicillatus* (Olivier).

Indo-Malayan seas (a female of small size, without locality).

*Palinurus* (*Panulirus*) *versicolor* (Latr.).

Aroe (Aru?) Islands (a young male, in which the coloration is excellently preserved). A young male from Samangkabai, and two others without definite locality, in the collection, probably belong to this species. When the characteristic coloration has disappeared, it is extremely difficult to distinguish young examples of this species from *P. ornatus*. In the adult *P. ornatus* the spines of the carapace, especially on the branchial regions, appear to be more numerous than in *P. versicolor*.

*Palinurus*\* (*Panulirus*) *longipes*, A. M.-Edwards.

As the specimen before me differs in some particulars from M.-Edwards's description, I subjoin the following:—Carapace covered with spines interspersed with numerous smaller spinules or spinuliform tubercles; none but the smaller spinules on the sides of the branchial regions of the carapace. Upper surface of the antennal segment covered with spines disposed as follows:—two long spines placed somewhat in front of the middle of the segment; anterior to these, four small median spinules in a transverse series; and posterior to them, six disposed in a semicircle. There are usually indications of several yet smaller spinuliform tubercles on the posterior part of the segment; of those above mentioned, all are not always equally developed.

The dorsal surface of the postabdominal segments is marked with a transverse uninterrupted sulcus; their lateral prolongations terminate each in a long spine; the lateral spines of the

\* The British Museum has recently obtained by purchase a specimen of *Palinurus* from Sydney Harbour, New S. Wales, that I refer to the rare *P. Hügelii*, Heller, which is covered by numerous examples of a species of pedunculated Cirripede which I refer to the species long ago figured by Quoy and Gaimard (Voy. Astrolabe, pl. xciii. fig. 5, 1834), and designated by Darwin (from the figure only) as *Alepas tubulosa*. So far as I am aware, this species has never been observed since the time of its discovery. As Darwin supposes, it may be distinguished from its congeners by the smooth, entire, carinated edge of the capitulum. The orifice, although tubular, is less protuberant than in the specimen figured by Quoy and Gaimard.

first postabdominal segment are straight ; in the four following segments they are curved backwards, and are surmounted by a second smaller spine, situated at the postero-lateral angles of the segment ; in the sixth segment there are no postero-lateral spines. The distal end of the merus of the ambulatory legs is armed with two spines. The colour (of specimens dried and in spirits) is bluish purple or reddish ; the carapace, larger spines, antennæ, and segments of the postabdomen are covered with numerous pale yellow spots ; and the legs are marked with longitudinal lines of the same colour, which are sometimes broken into irregular spots or blotches.

Indo-Malayan seas (an adult male without locality).

Of this beautifully marked species there are also in the Museum collection two adult males from Aneiteum (New Hebrides), and a smaller female from the Mauritius. A. M.-Edwards also records it from Zanzibar.

In the female the spines on the sternum, between the bases of the fifth ambulatory legs, which are prominent and well-developed in the males, are present, although of much smaller size. The carapace in all the specimens is more or less covered with short stiff hairs, arranged in short lines in front of the bases of the spines.

The pale yellow spots on the postabdominal segments are of unequal size ; about four on each segment are larger ; and of these the largest is situated on each side above the base of the lateral spines.

*Enoplometopus pictus*, A. Milne-Edwards.

Amboina (an adult male).

The example before me of this very rare and interesting species, which was previously unrepresented in the Museum collection, agrees in every particular with the description and excellent figure of M. A. Milne-Edwards ("Faune Carcinologique," in Maillard's 'Notes sur l'île de la Réunion,' Annexe F, p. 14, pl. xix. fig. 1), except only that the *chela* of the anterior legs are represented as somewhat broader in proportion to their length, with the tubercles of the upper surface more developed—characters on which it would certainly not be safe in any case to separate the two as distinct.

Perhaps the nearest ally of the genus *Enoplometopus* is to be found in *Eutrichocheles modestus*—a Malaysian form only known to me from Herbst's original figure and description (Naturg. Krabben u. Krebse, ii. p. 173, pl. xliii. fig. 2, 1794), and from the few remarks of Prof. Wood-Mason (Proc. Asiatic Soc. Bengal, p. 231, 1875), by whom the species has lately

been rediscovered, and the genus *Eutrichocheles* constituted for its reception. If, however, the figure be correct (and Mr. Wood-Mason says it is an accurate representation of the species), the first pair of legs has a much shorter hand, with proportionally longer and more strongly toothed fingers; the second pair of legs terminate in perfectly formed chelæ, whereas the third and following pairs are simple. In *Enoplometopus pictus* the penultimate joint of the four posterior pairs of legs terminates in a mobile spine, against which the spinuliferous dactylus is partially reflexible.

As the specimen of *Enoplometopus pictus* is unique, I have not been able to dissect the branchiæ, so as to make a complete examination of their arrangement. I may observe, however, that *Enoplometopus* is a Homarine form, belonging to the family Homaridæ as defined by Prof. Huxley in his recent classification of the *Astacina*, by their branchial characters (Proc. Zool. Soc. 1878, p. 781). As in the genera *Homarus* and *Nephrops*, the podobranchiæ are completely divided into a branchial and epipoditic portion; but the following remarkable peculiarity appears to exist in the structure of the podobranchia of the second maxillipede. In *Homarus* (as Prof. Huxley has pointed out) this gill is completely differentiated, in the usual way, into a branchia and epipodite; but in *Nephrops* the branchial plume is absent or rudimentary. In *Enoplometopus*, however, so far as can be judged from the examination of a single specimen and without actual dissection, the epipoditic portion is absent, the branchial plume being developed and of the normal structure; in other words, the modification of the typical branchia is the exact reverse of that observed by Prof. Huxley in *Nephrops*.

There is in the British Museum a specimen, unfortunately mutilated and in bad condition, of a species of *Enoplometopus* from St. Helena (*J. C. Melliss, Esq.*), which is distinguishable from the Indo-Pacific *E. pictus* by the slenderer chelipedes, which are smooth above, and by the existence of a distinct tooth on the lateral margin of the second to fifth postabdominal segments (see Pl. XV. fig. 7). This I will designate *E. dentatus*. The rostrum is broken off near the base; and the branchiæ are so rotten, from long immersion in weak spirit, that unfortunately nothing can be said of their structure with certainty; or it would have been interesting to know whether this Atlantic species assimilates in its branchial characters to its Indo-Pacific congener, or to the Mediterranean and North-European *Nephrops*, to which *Enoplometopus* bears so much external resemblance. It is of course possible, although it does not seem probable, that the epipodite, in the single speci-

men I have examinad, has been broken off, and that the genus, although presenting greater affinities in its external characters to *Nephrops*, is in reality more nearly allied to *Homarus*.

#### CARIDEA.

*Atya moluccensis*. (Pl. XV. figs. 3, 4.)

? *Atya moluccensis*, De Haan, Faun. Japon. Cr. p. 186 (1849).

*Atya armata*, A. M.-Edwards, Ann. Soc. Entom. France (ser. 4), iv. p. 149, pl. iii. fig. 3 (1864).

Java (an adult male); Batjan (an imperfect example); Bali (two females with ova); Celebes, Macassar (an adult female with ova).

In these specimens the rostrum is slender, acute, and narrowing to its distal end. In the adult male from Java (which agrees excellently with A. M.-Edwards's description and figure of *A. armata*) the third legs are considerably dilated, and the merus is armed below with a strong spine placed at some distance from the distal end of the joint. In adult males from the Samoa Islands of a closely allied species (probably *A. spinipes* of Newport), the rostrum is less acuminate, and appears in a lateral view more rounded toward the distal end, and the strong spine of the merus of the third legs is placed quite close to the distal end of the joint (see the figure, Pl. XV. figs. 5, 6). The types both of *A. spinipes* and of *A. pilipes*, Newport, are small and in bad condition; and it is probable that they are not specifically distinct. It is remarkable that the New-Caledonian *A. armata* should be identical with (or, at all events, much more nearly allied to) the Malaysian rather than the Samoan species. Two other forms described by A. M.-Edwards from New Caledonia, *A. robusta* and *A. margaritacea*, are distinguished by the form of the rostrum, which is armed at base with two ridges ending in short spines.

The true habitat of *A. pilipes* (as I have elsewhere noted) is Upolu, in the Samoa Islands, not New Zealand (Cat. New-Zeal. Crust. p. 79, 1876).

#### *Palæmon carcinus*, Fabr.

Java (an adult and full-grown male); Bali (an adult and a much smaller male).

In the smaller example the rostrum, although nearly of the same form, is less strongly sinuated, and the teeth are somewhat less numerous ( $\frac{12}{9}$ ). In the larger examples the rostra are respectively  $\frac{15}{2}$ - and  $\frac{13}{0}$ -toothed. In these examples the terminal postabdominal segment is less narrowed and acute at

its distal end than is usual in *P. carcinus*, and seems to approach the form of this segment in *P. Rosenbergii*, a species recently described by Mr. de Man, and founded on a unique example. Possibly a larger series would show that the latter is not specifically distinct.

*Palæmon ornatus*.

*Palæmon ornatus*, Olivier, Encycl. Méth. Hist. Nat. viii. p. 660 (1811); Latr. Encycl. Méth. Atlas, pl. cccxviii. fig. 1: M.-Edw. Hist. Nat. Crust. ii. p. 396 (1837); v. Martens, Arch. f. Nat. xxxiv. (i.) p. 36 (1868); Miers, Phil. Trans. Roy. Soc. clxviii. p. 493 (1879).

*Palæmon vagus*, Heller, Sitzb. Ak. Wien, xlv. i. p. 417, pl. ii. figs. 42, 43 (1862).

*P. equidens*, Heller, t. c. p. 418, pl. ii. fig. 44 (1862).

*Palæmon reunionensis*, Hoffmann, Crust. in Recherches faune Madagascar, p. 33, pl. ix. figs. 66, 67 (1874).

*Palæmon mayottensis*, Hoffmann, t. c. p. 32, pl. ix. figs. 61, 62 (1874).

*Palæmon longimanus*, Hoffmann, t. c. p. 34, pl. ix. figs. 68, 69 (1874).

Celebes, Macassar (an adult male); Bali (an adult male).

The identity of *P. vagus*, Heller, and of *P. longimanus*, Hoffmann, with the very common and widely-spread *P. ornatus* is confirmed by Mr. de Man, by whom also *P. mayottensis*, Hoffm., is shown to be at most only a local variety of the same species. On the other hand, Mr. de Man (who had Hoffmann's types before him) regards *P. reunionensis* (which I have considered identical with *P. ornatus*) as synonymous with *P. equidens* of Heller, and the latter as distinct from *P. ornatus*. *P. equidens* was originally founded by Dana on an example in which the second legs were wanting and which is thus insufficiently known. But I can see no reason for regarding *P. reunionensis* or *P. equidens* as described by Heller, as distinct from *P. ornatus*, nor does Mr. de Man mention any character by which they may be separated with certainty. Both Heller's and Hoffmann's figures of the second legs show that they resemble those of *P. ornatus*, both in the proportions of the joints and characteristic tuberculation of the fingers.

*Palæmon dispar*.

*Palæmon dispar*, v. Martens, Arch. f. Nat. xxxiv. p. 41 (1868); Miers, Phil. Trans. Roy. Soc. clxviii. p. 493 (1879).

*Palæmon Alphonsianus*, Hoffmann, Rech. faune Madagascar, Cr. p. 35, pl. ix. figs. 63-65 (1874).

Samangkabai, Tandjong (an adult male).

In this example the rostrum (which is broken off at the tip) is  $\frac{10}{4}$ -toothed. The smaller leg of the second pair is wanting; but I do not doubt its identity with v. Martens's species. The teeth on the inner margins of the fingers are largest at base, and become smaller or obsolete toward the

distal end of the fingers in the three specimens in the Museum collection, which are males. The upper finger (or dactylus) is, in all three, more curved and a little shorter than the lower. Besides the specimen from Samangkabai, the examples in the Museum are from Rodriguez and the Samoa Islands.

*Palæmon lepidactylus*, Hilgendorf.

A small male in the collection, without definite locality, I refer, with some hesitation, to this species. The rostral formula ( $\frac{11}{2}$ ) and the form and proportional length of the joints of the larger leg of the second pair agree exactly with the description and figure of Hilgendorf (Monatsber. Akad. Berlin, p. 838, pl. iv. figs. 14-16, 1878). The hairs on the inner margins of the fingers of the smaller hand, however, are few and scanty, like those of the larger hand. The granules with which the surface of the joints of both limbs are covered are small, and only on the inner margin of each limb are developed into small spines.

The specimen is of small size, and probably does not present the fully adult characteristics.

Besides the above, there are in the collection three examples of *Palæmon* from Java, which may belong to a new and distinct species. In all, however, one or other of the large limbs of the second pair are wanting; and none, probably, of the specimens present the characters of the fully adult. I will therefore leave them undescribed for the present. They differ from *P. grandimanus*, Randall, in the form of the larger chela (which is not so greatly dilated and compressed, with the fingers meeting along their inner edges when closed), from *P. javanicus*, Heller, in the much shorter carpus of the second legs (which is much shorter than the palm), and from *P. latimanus*, Von Martens, in the more numerous teeth of the rostrum.

[To be continued.]

XXXVI.—*On a Collection of Lepidoptera from Madagascar, with Descriptions of new Genera and Species.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

[Continued from p. 344.]

**Liparidæ.**

**XANTHODURA, gen. nov.**

Form of the eastern genus *Dura*, but more nearly allied to *Orgyia*. The antennæ very small; body very short. Prima-

ries with the costal vein extending to second third of costa ; discoidal cell extremely short, not extending to the middle of wing ; subcostal four-branched, all the branches emitted at some distance beyond the cell, the last, moreover, from below the main vein ; both radials emitted close together from the upper extremity of the cell ; discocellular inarched, second and third branches emitted near together. Secondaries much elongated and sublobate in the middle of outer margin between second and third median branches ; cell very short, as in primaries ; costal and subcostal veins emitted from a curved basal pedicle ; subcostal emitting its two branches from a short footstalk just beyond the cell, radial emitted from the superior extremity of the cell ; discocellular slightly inarched, second and third median branches emitted close together from the inferior extremity of the cell. Type *X. trucidata*.

### 39. *Xanthodura trucidata*, sp. n.

Orange ; primaries with the apical third, including the external border, chocolate-brown, its inner margin, terminating in a patch at external angle, dark blood-red : secondaries with a blood-red apical patch ; fringe at apex dark brown ; head and collar ferruginous, with white borders ; antennæ black. Wings below orange ; primaries with the apical third chocolate-brown ; secondaries with a chocolate-brown apical patch : body below cream-coloured. Expanse of wings 1 inch.

### LECHRIOLEPIS, gen. nov.

♀. Aspect of *Charotriche*, but the antennæ serrate instead of pectinate, the anal tuft enormously developed, considerably more so even than in *Anaphe* ; neuration entirely different. Primaries with the subcostal area partially bare in the middle, the scales upon it being placed edgewise and transversely ; these scales are very thick, corneous, and curved, some of them being considerably more elongated than the others, and all of them being fringed or finely serrate at the distal extremity ; costal vein nearly extending to apex ; subcostal six-branched, the first four branches being emitted before the end of the cell, the second and third from a long footstalk, the fifth and sixth branches from a short footstalk at the superior angle of the cell, the sixth branch representing the upper radial ; discocellular extremely fine, very oblique, and distinctly angulated ; median vein four-branched, the fourth branch being in reality the lower radial, but emitted with the third median from a short footstalk. Secondaries rather small for the family, and

with strongly convex costal margin (so that when at rest it appears in front of the primaries as in *Gastropacha*), densely fringed with hair; costal vein bifurcate from base, the superior furca terminating at the middle of the margin, and the inferior one a little before apex; subcostal simple, emitted close to the costal vein, which it almost touches just beyond the furcation; no discocellular; median vein four-branched. Type *L. anomala*.

40. *Lechriolepis anomala*, sp. n.

Ochreous: primaries traversed by three tawny stripes, the first of which is slightly irregular and crosses the wing at basal fourth, the second zigzag and central, the third discal, macular, and zigzag; a large ferruginous spot in the cell: secondaries pale towards the base; a central costal brownish dash: abdomen pale, with testaceous anal tuft, having dull golden reflections in fresh females, in which it has not been disturbed for the purpose of oviposition. Under surface uniformly ochraceous, excepting the anal tuft; costal area of primaries on each side of the singularly modified subcostal streak clothed with long appressed hairs mixed with ordinary scales. Expanse of wings 2 inches 4 lines.

Evidently not a rare species.

This genus is aberrant in almost every character, its neururation being, in fact, unlike that of any characterized genus of moths; the arrangement of the scales upon the partially bare patch on the primaries is, moreover, so abnormal that, but for the large anal tuft which the female evidently cuts off, like the genera *Euproctis* and *Porthesia*, to cover its eggs with, I should feel obliged to found a new family for its reception. As it is, I am satisfied that this and two other genera which I must characterize here are sufficiently aberrant to be regarded as a distinct subfamily, for which I therefore propose the name of *Lechriolepidinae*.

The two following genera were received in previous collections; but, from their similarity to known genera, their structural differences were unfortunately overlooked.

RAPHIPEZA, gen. nov.

Allied to *Lechriolepis*, but with the aspect of *Gogane*; in neururation it differs from *Lechriolepis* as follows:—primaries with the lower radial emitted from the superior angle of the cell instead of as a fourth median branch; discocellular transverse and slightly angulated; costal vein of secondaries with its superior furca extremely short, so as to answer the purpose of a precostal veinlet, subcostal with two branches. In other



respects it is similar ; the inner margin of the primaries has a central projecting patch of scales, amongst which are several long needle-like steel-blue scales. Antennæ with short pectinations. Type *R. turbata* (*Gogane turbata*, Butl.) from Madagascar.

I have again examined the species originally described by me as *Gogane ochrea*, and can confirm my statement that it agrees in structure with *Chærotriche*, the neuration, antennæ, and other characters of the male being the same as in *C. vitellina*. The principal difference between *Chærotriche* and *Gogane* lies in the projecting patch of scales on the inner margin of the primaries possessed by the latter genus.

#### CHRYSOPSYCHIE, gen. nov.

This genus differs from the preceding (just as *Chærotriche* does from *Gogane*) in the absence of any patch of projecting scales on the inner margin of the primaries ; in all other characters, including the remarkable patch of transverse horny scales, it is extremely similar ; the thorax, as in *Chærotriche*, is armed with long radiating clavate scales. Type *C. mirifica* (*Chærotriche mirifica*, Butl.) from Old Calabar.

Neither this genus nor *Raphipeza* possess the large anal tuft of *Lechriolepis*.

#### Lasiocampidæ.

##### 41. *Lebeda tamatave*?

*Lasiocampa tamatave*, Guénée in Vinson's Voyage à Madagascar, Appendix F, p. 44. n. 23 (1865).

The *Lebeda badia* of Saalmüller seems to be a nearly allied but paler species.

#### Saturniidæ.

##### 42. *Copaxa subocellata*, sp. n.

Wings above primrose-yellow, crossed at basal fourth by an ill-defined ferruginous stripe, beyond which the ground-colour to the middle of the wing is washed with reddish ; a diffused dull ferruginous central stripe limiting internally a broad paler ferruginous discal belt, the outer margin of which is dusky, slightly multisinuate on the primaries and zigzag on the secondaries ; a submarginal series of large subocellate pale lilac spots, which on the primaries are confluent, their margins tinted with ferruginous ; outer border, particularly on the primaries, washed with ferruginous ; primaries with a small pale-zoned black-edged hyaline white semicircular spot at the end of the cell, base of costa dull rose-coloured : body dull

rose-coloured, thorax in front and collar ochraceous; palpi and head deep rose-coloured; antennæ ochreous; margins of abdominal segments ochreous. Under surface nearly as above, but the markings less distinct. Expanse of wings 4 inches 4 lines.

### Limacodidæ.

#### CROTHÆMA, gen. nov.

♀. Aspect of *Edibessa*, but apparently nearer to *Alpis*. Primaries trigonate, the costal margin nearly straight, outer margin very slightly convex, inner margin distinctly convex; under surface of primaries deeply hollowed out behind the costal border, which consequently stands up like a wall in front of the cell; costal vein extending to second third of costa, discoidal cell very wide; subcostal vein five-branched, the first three branches emitted before the end of the cell, the fourth and fifth from the same point at the anterior extremity of the cell; upper discocellular transverse, emitting the upper radial from its centre; lower discocellular oblique, so that the lower radial looks like a fourth median branch; two convergent recurrent veins from the discocellulars to beyond the middle of the cell, median veins emitted at equal distances towards the end of the cell. Secondaries ovoid; costal vein extending to apex; subcostal two-branched, both emitted from the end of the cell, but not from the same point; discocellulars zigzag, emitting the radial from the middle and sending back two convergent recurrent veins into the cell as in the primaries; median vein three-branched. Body rather slender for the family; antennæ thick and compressed, but not pectinate; legs rather long, tibiæ with long spurs. Type *C. sericea*.

#### 43. *Crothæma sericea*, sp. n. (no. 56).

Primaries above silky pink; a patch at base of costa, a broad, irregular, interrupted, oblique central patch and an oblique apical patch bronzy greenish, with whitish borders: secondaries salmon-coloured, sericeous: thorax bronzy greenish, abdomen bright rose-red. Under surface rose-coloured, costal margins and apices of wings and legs yellowish. Expanse of wings 1 inch 7 lines.

### Cossidæ.

#### 44. *Hypopta breviculus*.

*Cossus breviculus*, Mabille, Ann. Soc. Ent. France, 1880, p. 344.

♂. Primaries snow-white, clouded with grey and transversely reticulated with grey and black; a quadrate reddish-

brown spot on the lower radial interspace between two divergent black lines, and a second just beyond the middle of the interno-median area: secondaries sordid white, with pure white fringe: body pale silky brownish, with the head and collar slightly darker. Primaries below with the markings very indistinct: secondaries rather whiter than above, with the base of the fringe and two or three subapical striæ grey: body below whitish; legs banded with blackish. Expanse of wings 1 inch.

Some examples are rather smaller than the type.

#### Notodontidæ.

##### 45. *Rigema ornata*.

*Rigema ornata*, Walker, Cat. Lep. Het. Suppl. 2, p. 437 (1865).

Previously known only from Natal.

#### Erebidæ.

##### 46. *Sypna complicata*, sp. n.

Greyish fuliginous: primaries very dark, blackish upon basal half excepting upon the costa; two slender twisted white lines across the basal area; an oblique zigzag white line from costa to inner margin across the middle of the cell; a white-edged pentagonal black patch over the end of the cell, two or three very irregular twisted white lines crossing the wing transversely just beyond the cell; a deeply sinuated white line limiting the external border, which is pale; a marginal series of white-edged black spots; fringe white, tipped with blackish: secondaries with a diffused blackish discal belt, which becomes quite black, and is bordered externally by an angulated white line at anal angle; fringe as in primaries; an indistinct oblique apical white line: head and collar testaceous, remainder of body above densely clothed with pale brown and whitish scales. Wings below greyish, speckled with white: primaries with a spot in the cell, an arched belt just beyond the middle, the external border from near apex almost to the first median branch, and an oblique dash at external angle whitish; the marginal spots and fringe nearly as above: secondaries with a dusky-bordered, whitish-speckled, arched postmedian belt; outer border whitish; a blackish spot at the end of the cell: body below greyish fuliginous. Expanse of wings 2 inches 1 line.

Hitherto the described species of this genus have all come from the Indian region.

**Ophiusidæ.**47. *Ophiodes tirrhæa* ♂.

*Phalæna Noctua Tirrhæa*, Cramer, Pap. Exot. ii. p. 116, pl. 172, fig. E (1779).

The secondaries of the male are spotless. Unless all the species of this type are to be regarded as varieties of one type, the European form will have to be kept separate under the name *O. vesta* of Esper.

**Ennomidæ.**48. *Marcala? modesta*, sp. n.

Dull clay-coloured, sericeous; wings crossed from apex of primaries to abdominal margin of secondaries by a straight oblique brown line; a black discocellular spot on all the wings, as well as three more or less defined abbreviated series of pearly-bordered black spots across the inner half of the disk; fringe reddish clay-coloured: body pale, the head, collar, and front of thorax yellowish. Under surface pale buff, reddish towards costæ and outer margin of primaries, the internal border of the same wings white; oblique line less distinct than above; discocellular spots smaller. Expanse of wings 1 inch 2 lines.

The known species of *Marcala* are Indian; the genus is allied to *Drepanodes* and *Crocini*.

**Geometridæ.**49. *Comibæna stibolepida*.

*Comibæna stibolepida*, Butler, Cist. Ent. ii. p. 394 (1879).

The example now received measures 2 lines more than the type in expanse of wings.

50. *Thalera Cowani*, sp. n.

Wings above sap-green, with chocolate-brown discocellular dots and outer margin; a dentate-sinuate dark sap-green discal line, oblique in primaries, angulated irregularly in secondaries; fringe snow-white; primaries with the costal margin brown; thorax greenish; head and base of antennæ snow-white, pectinations of antennæ yellowish, the greater part of the main stem ferruginous. Under surface pale creamy yellow; wings with laky-brown outer margin and white fringe; primaries with the costal area washed with reddish, costal margin brown; femora and tibiæ reddish in front. Expanse of wings 1 inch 3 lines.

51. *Thalassodes glacialis*, sp. n.

Wings above glistening white, semihyaline; primaries crossed by two zigzag series of white-edged sap-green spots; the outer one upon the disk continued across the secondaries; costal margin of primaries yellowish: body white, palpi ferruginous, antennæ testaceous. Wings below tinted with pale buff, especially the primaries, in which the costal margin is also bright golden yellow: body below pale buff. Expanse of wings 10 lines.

The secondaries of this species are very slightly angulated; so that possibly it may eventually have to be placed with other described species in a distinct genus.

**Acidaliidæ.**52. *Zanclopteryx puella*, sp. n.

Snow-white; wings semitransparent, with opaline reflections: primaries very acuminate at apex, costal margin golden buff; all the wings with a black dot at the end of the cell, a series of black dots on the veins across the disk, a greyish submarginal stripe, and a marginal series of black dots: antennæ, tips of palpi, and an elongated triangular spot at the base of each of the first three segments of the abdomen golden buff; proboscis yellow: upper surface of tibiæ of front legs golden buff. Wings below with a small dot at the end of the cell; primaries with golden costal border, otherwise immaculate: body below white. Expanse of wings 1 inch 3 lines.

In form and general appearance this species comes nearest to *Z. aculeataria*.

I have very little doubt that the genera *Argyris* and *Auzata* will prove by breeding to be closely allied to *Cilix* and referable to the Drepanulidæ; they are, however, always placed close to *Zanclopteryx*.

**Fidoniidæ.**53. *Panagra rachicera*, sp. n.

Pale shining whity brown, with the centre of primaries and the basal third of secondaries semihyaline white, limited externally by a dusky line from apex of primaries to abdominal margin of secondaries; the whole surface indistinctly striated with pale brown and sparsely speckled with black: secondaries with an irregular discal series of six black spots in pairs, the two central ones largest. Below, secondaries washed with sandy yellowish, the veins, costa of primaries, and the oblique line (which is diffused) distinctly golden yellow: body below creamy whitish. Expanse of wings 1 inch 6 lines.

In this species the pectinations of the antennæ exhibit the branching peculiar to this genus more prominently than in any species which I have seen.

### Zerenidæ.

#### RHODOPHTHITUS, gen. nov.

Nearly allied to *Icterodes* and *Vindasura*, but with the primaries more elongated, the secondaries considerably shorter, and the palpi longer. Type *R. formosus*.

#### 54. *Rhodophthitus formosus*, sp. n.

Primaries above flesh-coloured, with yellow costal border speckled with dull black, an oblique costal dash at basal third, a spot at the end of the cell, a very irregular subapical costal spot, and an oblique patch on inner margin near the external angle dull black; a grey streak at external angle; a faint indication of a brownish stripe connecting the subapical costal spot with the internal patch: secondaries rosy pink, with the outer half of abdominal area whitish, crossed by a black patch; several black spots in the cell; a transverse discocellular black spot: head black, antennæ dark brown; collar saffron-yellow; thorax flesh-coloured; abdomen yellow, irregularly spotted with black. Under surface rosy pink, costa of primaries bright yellow; spots as above; pectus deep rose-red; knees of legs blackish, tibiæ and tarsi greyish; venter yellow at the sides, with lateral black spots. Expanse of wings 2 inches.

In general coloration this insect is extremely unlike other Zerenidæ; but in neuration it scarcely differs from *Icterodes*.

### Larentiidæ.

#### 55. *Emmelesia sublutea*, sp. n.

Wings above shining sordid white, the basal area crossed by three irregular arched slaty-grey stripes, prominent black discocellular spots: primaries with the external third dark grey, spotted with black; a marginal series of black spots; fringe brown, whitish in the centre, spotted with black: secondaries with a lunulated ferruginous stripe just beyond the middle; external area snow-white, with the apex and an interrupted submarginal series of spots black; an almost marginal series of ferruginous spots and a marginal series of black spots connected by a slender undulating line; fringe whitish brown, becoming dark brown at apex: body brownish, with lateral black spots. Under surface straw-yellow: primaries

with the costa black-spotted, basal area speckled with blackish, the cell terminating in a large black spot; a dark grey spot on each of the median branches; external third black-brown, with a costal spot, an apical spot, a spot on outer margin, and a dot at external angle yellow: secondaries with a small lunule at the end of the cell and a large apical spot black, several scattered greyish dots and lines. Expanse of wings 11 lines.

The general appearance of this species is very similar to that of *Sandava scitisignata* (*Cidaria scitisignata* = *Sandava melaleucata* = *Istarba variabilis* of Walker) from Australia.

### Hypenidæ.

#### 56. *Agamana insignis*, sp. n.

♂. Primaries above dull pink, changing to flesh-colour internally, the costal margin reddish ferruginous; a sinuous white-edged blackish-olive band, widest towards the base of inner margin, where it commences, compressed in the middle, then angulated externally, and tapering to the apex; a black dot at the end of the cell: secondaries pale fuliginous brown, with darker outer border; costal area whitish brown; fringe rosy greyish: thorax reddish olivaceous, barred with pink; abdomen pale fuliginous brown; palpi red internally. Under surface pale brown; primaries with the central area greyish, the inner margin whitish; secondaries with whitish basal area: body below whitish brown, legs reddish. Expanse of wings 1 inch 6 lines.

The palpi of this species differ from those of the typical species in being porrect instead of depressed: the specimen of that species, however, is a female; and in the sexes of the Deltoids there is frequently a considerable difference in the palpi. The neuration appears to be identical.

### Cledeobiidæ.

#### 57. *Actenia? signata*, sp. n.

Most like *A. brunnealis*: primaries flesh-tinted, black-speckled, with diffused olive-brown borders; a broad, externally diffused, dark brown oblique stripe across the basal fourth, and an internally diffused similar but angulated stripe across the disk; a large, whitish-bordered, black spot at the end of the cell: secondaries stramineous: head and thorax flesh-tinted; abdomen stramineous. Under surface stramineous: wings crossed by a greyish discal stripe and with sordid external border, blackish discocellular spots; primaries with the base of the cell greyish. Expanse of wings 1 inch.

**Gelechiidæ.**58. *Gelechia insularis*, sp. n.

Dark fuliginous brown: primaries crossed before the middle by a broad, pale-edged, golden-ochreous belt, which does not quite reach the costal margin; a small, ocelloid, black-brown spot, margined with stramineous, beyond the cell, followed immediately by an externally blackish-bordered, curved, golden-ochreous discal band; apex and outer margin whity brown; marginal line black; fringe ochreous at apex and for a short distance along the costa: secondaries paler than primaries, without markings: head golden opaline; antennæ banded with whitish; palpi with a central band and the apical joint whitish. Under surface paler than above and more sericeous: primaries with the apical costal fringe ochreous, inner border whitish, markings of the upper surface obsolete; secondaries with the apical area apparently speckled with dark grey and whitish. Expanse of wings 6 lines.

59. *Cryptolechia argillacea*, sp. n.

Primaries above reddish ochraceous, with darker punctiform orbicular and reniform spots, base of inner margin ferruginous; secondaries very pale stramineous; thorax reddish ochraceous; head whitish; palpi brown, with white apical joint; abdomen pale stramineous. Under surface pale stramineous; wings washed with ochreous along the costal borders, primaries also along the external border, and secondaries from apex to about the second median branch. Expanse of wings 1 inch  $2\frac{1}{2}$  lines.

The following undescribed butterflies are in the collection of the late W. C. Hewitson.

*Charaxes relatus*, sp. n.

♂. Nearly allied to *C. zoolina*, but the primaries above much less obscured with brown at the base, and with the abbreviated band arrested at the second instead of at the first median branch; the spots on the apical area smaller, the one just above the third median branch reduced to a mere point: secondaries much more elongated, the border with sharply cut straight inner edge, the transverse black line across the subcostal branches wanting, the submarginal spots reduced to points, the deep orange border replaced by a much shorter greenish-yellow border. Wings below with all the bands considerably darker and margined with black, the silvery spot



on the posterior extremity of the third band of primaries transferred to the costa of secondaries; submarginal spots of primaries considerably enlarged: secondaries with the inner series of silvery spots on the outer border reduced to one or two squamose lines, the submarginal spots five in number, and the ocelloid anal spots consequently reduced to three in number; the anal area and border dull greenish instead of orange. Expanse of wings 2 inches 6 lines.

This species is referred to as an unknown form at p. 100 of the Catalogue of the Collection.

*Iolais argentarius* ♂, Butler.

The male of this species is of a beautiful steel-blue colour with azure reflections: primaries above with the costa brown, the apical half brown with zigzag inner edge; secondaries with the costal border brown, the abdominal area rather broadly pale greyish brown, two large, internally whitish-edged and externally blue-edged black spots above the tails, and two or three small linear spots connecting these with the costal border. Wings below greyish brown, with white-bordered black lines and spots arranged as in the female, and with the same orange-bordered black spot and black-centred emerald-green anal spot. Expanse of wings 1 inch 6 lines.

The female which accompanies this male is not of the same pure colour as the type on the under surface, the ground-colour being distinctly grey, and the white borders of the black lines almost as distinctly visible as in the male.

*Catopsilia rufosparsa*, sp. n.

♀. Above like the Indian *C. gnoma*, but below of a dull dark ochraceous colour, with the cross reticulations much more numerous and orange instead of greenish grey, and mixed with blood-red speckling; the discal spots indistinct and confused, only represented by subconfluent groups of reddish scales as in *C. florella*; silver spots smaller. Expanse of wings 2 inches 6 lines.

The type also differs from *C. gnoma* on the upper surface in the confluence of the apical marginal red spots and the absence of any trace of a discal series, in the absence of a white vein across the discoidal black stigma, in the pink tint of the secondaries, and the presence of a marginal series of red spots upon the yellow border; but all these characters may vary, whereas the denser reticulation and confused speckling of the under surface is characteristic of African and not of Indian species. (See p. 33 of Catalogue of Hewitson's Collection.)

XXXVII.—*The Sponge-fauna of Norway ; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. SOLLAS, M.A., F.R.S.E., F.G.S., &c.

[Continued from p. 259.]

[Plate XVII.]

Group *GEODINA*, Carter (*continued*).

Genus *ISOPS* \*, nov. Type *I. Phlegraei*, sp. nov.  
(*Geodia* auct.)

*Diagnosis*.—Excurrent and incurrent apertures similar, being the freely open ends of simple cylindrical tubes, which sink directly into the rind of the sponge and end at its inner surface in sphinctral muscles.

*Observations*.—The ostia of the canal-system are of very various sizes, forming a series in which the largest pass into the smallest by almost insensible gradations. The larger apertures serve as excurrent and the smaller as incurrent ostia.

The simple nature of the ostia and the identity in structure of the incurrent and excurrent ostia and ostial tubes constitute a good distinction between this genus and its allies—*Geodia*, *Cydonium*, and *Pachymatisma*.

The incurrent ostial tubes of *Isops* may be regarded as equivalent to the chones of the preceding genera deprived of their perforate (poriferous) roof.

The excurrent ostial tubes differ from those of *Geodia* in being simple and dispersed, the cribriform area or ostial tube with many sphincters of *Geodia* being possibly due to the integration or coalescence of a number of simple tubes similar to those of *Isops*, thus :—



1. Ostial tubes of *Isops*, closely congregated.

2. Excurrent tube of *Geodia*, formed by the coalescence of similar ostial tubes.

\* *Isops*, equal ;  $\Delta\psi$ , an eye (hence a hole).

How far other distinctive characters will be found constantly associated with those given as diagnostic of the genus *Isops*, one cannot at present say. As yet only a single representative of the genus (*I. Phleggræi*) is known to me; between it and *Geodia Barretti*, however, very characteristic differences exist. Thus the former does not possess any of the small acerate spicules, which, projecting erectly from its surface, form the fine superficial down of *G. Barretti*; they appear to be entirely replaced by the large long-shafted spicules which form the externally projecting fascicular ends of the internal spicular fibres. The trifid heads of the long-shafted spicules, moreover, do not, as in *G. Barretti*, apply themselves with horizontally extended rays to the inner surface of the globose layer, but, projecting forwards, penetrate and terminate within the globose layer. At present, however, it is uncertain whether these characteristic differences are generic or specific merely.

*Isops Phleggræi* \*, n. sp.

*Sponge* more or less spherical, about 1 inch in diameter; surface hispid (when unworn) by the protrusion of long-shafted spicules for about 0.15 inch beyond it; when the spicules are worn away the surface is smooth and of a faint greyish colour. Excurrent and incurrent ostia simple, numerous, scattered. Each ostium a small round or oval opening, situated on the summit of a conical elevation, which is very variable in size, but always minute, the largest measuring 0.125 inch in diameter at the base, and 0.025 inch at the summit; in some cases the elevation may be almost entirely absent, the ostium then lying flush with the general surface of the sponge. Over some parts of the surface small white spots occur, some of which are really and some only apparently imperforate, the latter showing a minute central aperture on magnification. These are the smallest ostia present; between them and those of the largest perforate monticule we have others of every intermediate size.

*Skeleton*.—The skeleton consists of long-shafted spicules, globates, and stellates.

*Thick long-shafted Spicules*.—(i) a simple, sharp-pointed, fusiform acerate, 0.24 inch long by 0.0025 inch broad (Pl. XVII. fig. 5); (ii) a trifid spicule with simple, forward-projecting rays, shaft 0.16 inch long, 0.0017 inch broad, rays 0.025 inch long (Pl. XVII. fig. 7); (iii) a trifid spicule, with

\* In reference to the ostial elevations of its surface, reminding one of the *Campi Phleggræi*.

irregular bifurcated rays, shaft 0·13 inch long, rays 0·034 inch long (Pl. XVII. fig. 9).

*Slender long-shafted Spicules*.—(i) a simple sharp-pointed acerate, 0·0004 inch thick; (ii) a trifid spicule with rays recurved anchor-like, 0·0008 inch thick (Pl. XVII. fig. 6); (iii) a trifid spicule with rays directed forwards, 0·0008 inch thick (Pl. XVII. fig. 8).

*Stellates*.—(i) a sphæro-stellate with a large body and numerous short conical rays, 0·0005 inch in diameter (Pl. XVII. fig. 12); (ii) a stellate with small body and a few long rays, usually about 0·0008 inch in diameter (Pl. XVII. fig. 13), but often becoming exceptionally large, as much as 0·0015 (Pl. XVII. fig. 10), or rarely even 0·0027 inch in diameter.

*Globates*.—Oblate and prolate ellipsoids, the latter with one minor axis shorter than the other; covered superficially by erect tubercles, having a more or less flattened polygonal summit, from the corners of which minute short slightly recurved spines are produced. Diameter 0·0036 inch (Pl. XVII. fig. 14).

*Locality*. Kors Fiord, Station No. 23: 180 fathoms.

*Observations*.—A section across the sponge shows a thin rind (0·025 inch thick) enclosing a greyish-yellow mark, which is traversed by numerous canals of various sizes. Those large enough to be plainly visible to the naked eye have smooth glistening walls, concentrically striated by fine rugæ: some take a concentric, others a radiate course, the same canal being concentric in one part of its course and radiate at another. The crypts are very irregular in size, some being markedly larger than others; they have lost the characters which distinguish them in *Stelletta Normani*, and appear to be the cut ends of concentric canals, precisely similar to those occurring in the mark, and only differing in being situated immediately beneath the rind; indeed it occurs to one to suggest that both in this instance and in *Geodia Barretti* the concentric canals are merely the cryptal canals left behind in the progressive increase of the sponge.

### *Histology.*

1. *The Cortex*.—The *epidermis* consists of a very distinct transparent, colourless, and apparently structureless cuticle, lying quite separate from the succeeding dermal layer; no nuclei nor cell-borders are observable in it (Pl. XVII. fig. 11, c). The *dermal layer* consists of very definite colourless, granular, oval cells, lying quite separate from one another, and forming a layer of variable thickness; sometimes it thins out altogether and lets down the epidermis into immediate contact with the globate layer; sometimes, on the other hand, it thickens out

so as to become three or four cells deep; but usually it consists of a single layer of cells only. Just below the epidermis sphæro-stellates occur between the dermal cells, their rays projecting against the epidermal membrane (Pl. XVII. fig. 11, *d*).

No vesicular nor gelatinous connective tissue is observable in the dermis.

*The Globate Layer.*—The structure of this does not differ from that described as existing in *Geodia Barretti*, except by the absence of vesicular connective-tissue cells from the triangular spaces left between the fibrillar ligaments; these cells are replaced here, as elsewhere in *Isops Phlegreæ*, by gelatinous connective tissue. The most exterior, and therefore oldest, of the globates of the rind are very often hollow within, the small central cavity which exists in the ordinary adult globate having become enlarged to a great but variable extent. This occurs as the result of an absorption which begins at the inner ends of the trichites, and, extending radiately outwards, reproduces the early form of the young globate as a hollow cast within the old one; the same result is brought about by exposing the solid mature globates to the action of boiling caustic potash, as described by me in a previous communication to this Magazine (Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 292).

*Subcortical Layer* (Pl. XVII. fig. 4).—The purely fibrous part of this (fig. 4, *f*), which lies immediately beneath the globate layer, is very thin, and passes below into gelatinous connective tissue (fig. 4, *c*), in which fibres like those of the fibrous layer lie loose and more or less apart from each other, and being consequently well defined are easily studied *in situ*. They are hyaline and fusiform, with attenuated ends, sometimes greatly prolonged; a central axis is rarely visible; more usually the interior is occupied by an axial cavity; generally it would appear empty, but sometimes contains a small refringent spherule, which I take to be a nucleolus, and is sometimes filled with colourless granular material. The axial cavity may be relatively very small, a mere slit in the centre of the fibre; or it may be large, perforating the whole length of the fibre, and converting it into a genuine tube. The tube so formed is liable to split open at one end; when this happens the slit wall uncurves and spreads out into a thin lamina. The hyaline wall of the fibre frequently also becomes fibrillated and sometimes apparently laminated; it then becomes liable to exfoliation or defibrillation, as the case may be.

The gelatinous connective tissue consists of a colourless, structureless, soft matrix, containing numerous dispersed oval nuclei surrounded by a small quantity of granular colourless

protoplasm, from which in many cases very fine fibrils are prolonged irregularly in various directions. Here and there greyish granular oval cells (Pl. XVII. fig. 16), which have a very distinct outline, and stain deeply with carmine, occur in the matrix. Each one generally occupies a corresponding cavity in the matrix, from which it is completely separated except at one or two points of contact; this separation is probably the result of contraction after placing in spirit. These cells are often pointed at one end, which differs from the rest of the cell in being hyaline and more refringent. The pointed end is sometimes produced into a fine structureless fibre (Pl. XVII. fig. 15).

2. *The Mark*.—The substance of the mark consists of minute granules abundantly dispersed throughout a structureless colourless matrix, forming a greyish tissue, in which small oval nuclei occur at intervals. It stains generally with carmine, but not so deeply as the corresponding tissue of *Stelletta Normani* and *Geodia Barretti*.

It never presents any appearance which might suggest that it consists of a number of separate but closely apposed cells, although, from the remarkably perfect manner in which other delicate histological features of the sponge are preserved, one would expect evident signs of such a constitution if it existed; and as, on the other hand, it is not a mere gelatinous connective tissue like the mark of *Thenia Wallichii* and many other sponges, we may at least provisionally regard it as a genuine syncytium.

3. *The Skeleton. Long-shafted Spicules*.—The long acerates lie longitudinally side by side, forming spicular fibres, which take chiefly a radiate direction from the centre of the sponge towards the rind. On approaching the rind the constituent spicules of each fibre diverge from each other and pass out of the sponge in the form of a fascicle; at the same time trifold spicules put in an appearance, the coarser forms having their heads within, below, and outside the rind, the finer, grapnel-like and slender fork-like forms bearing their heads exclusively outside and at some distance from the rind. In *Geodia Barretti*, it will be recollected, all forms of trifold spicules were exclusively confined to the interior of the sponge, their heads occurring just beneath the rind. The frequent irregularity in the form of the bifurcated ternate spicule of *Isops* is caused by the obstruction of the globates in which it is imbedded, these obstacles hindering its free growth. With each spicular bundle or fibre is associated a tract of tissue very similar to, and, indeed, almost identical with, that of the subcortical layer; it consists of (i) finely granu-

lar cells, which do not differ in general characters from the isolated definite oval cells which have already been mentioned as occurring here and there in the mark and subcortical layer: many of them, indeed, are identical with these in all respects; but most differ in form, becoming much elongated in the direction of the spicular bundle, and thus acquiring a more or less fusiform outline. The nucleus is involved in this change of form, becoming also elongated and fusiform; but the nucleolus is unaffected and retains its spherical form.

These fusiform cells, by becoming gradually hyaline, afford an easy passage into (ii) ordinary hyaline fibres of precisely the same nature as those of the subcortical layer; they lie parallel to the spicules of the spicular bundle, to which they form an enclosure. Sometimes a surrounding band of concentric fibres occurs around the bundle. Finally, (iii) a small quantity of gelatinous connective tissue is in places associated with the spicular bundles.

Where the spicular bundles enter the cortex the fusiform hyaline fibres can be easily followed, diverging from the spicules in a gentle outward curve and entering the subcortical layer, which therefore may be regarded as an extension of the tissue of the spicular tract, modified by increase of growth and change of direction. The change of direction is in accordance with that of the long-shafted spicules, the trifid ends or distal rays of which tend, on reaching the rind, to become more concentric and less radiate in direction. Just below the place where the fibre curves from the spicules to the cortex a number of granular cells, like those described in the same position in *S. Normani*, are often found accumulated.

In addition to a tissue of the bundle there is the tissue of each individual spicule, each being invested in an excessively thin structureless membrane containing small round nuclei surrounded by fine granules and very thin structureless fibrils (Pl. XVII fig. 2, *s*). Now and then one finds isolated hyaline fibres encircling a spicule like a girdle (Pl. XVII. fig. 2, *z*); the meaning of this feature, which is to be found in other related sponges, is not apparent.

*Globates*.—The structure and development of these spicules can be studied with great facility in this sponge. The earliest form consists of a cell (Pl. XVII. fig. 21, *s*) of the same size as the common, isolated, oval, granular cell of the mark (Pl. XVII. fig. 21, *m*); it contains the little sphere of radiate trichites, which are united together at their inner ends about a small, central, spherical space; externally they terminate in a layer of hyaline sarcod or cell-wall. On one side of the cell is imbedded a round or, more commonly, oval nucleus with its

contained spherical nucleolus. By treating with a 5-per-cent. solution of caustic potash, the cell-wall expands and separates from the contained globates completely (Pl. XVII. fig. 19). With age a hilum is formed, as previously described in the case of *G. Barretti*; but the nucleus merely occupies and does not completely fill the hilum (Pl. XVII. fig. 18), as erroneously stated in the previous description (Ann. & Mag. Nat. Hist. ser. 5, vol. v. p. 256). The external ends of the trichites grow much thicker with age, and assume a sharp conical form; the sharp ends of the conical spines then become rounded off and pass into rounded conical tubercles; these finally become flattened and spined round the summit, and the globate is complete. Absorption next ensues. The adult globate always exhibits in section a small central cavity with fine radiate canals proceeding from it; the effect of absorption is to enlarge this cavity and its radiate canals, so that the globate becomes eventually a mere thick-walled shell, its walls being perforated by radiate canals of wide diameter which extend along the axes of the exterior tubercles, and almost but not quite open to the exterior (Pl. XVII. fig. 24).

It appears that the layer of tubercles is liable to separate as a thin shell from the rest of the globate spicule.

*Stellates*.—The same kind of distribution of the stellates occurs here as in *G. Barretti* and *S. Normani*; none but the sphæro-stellates occur immediately beneath the epidermis; elsewhere the second kind of stellates (Pl. XVII. fig. 13) are chiefly found; the sphæro-stellates occur in the mark immediately beneath the rind, but less abundantly than the other forms. The small-bodied stellates occur lining the interior of the sphinctral canal, in the subcortical layer, and generally through the mark, but especially in the wall of the water-canals.

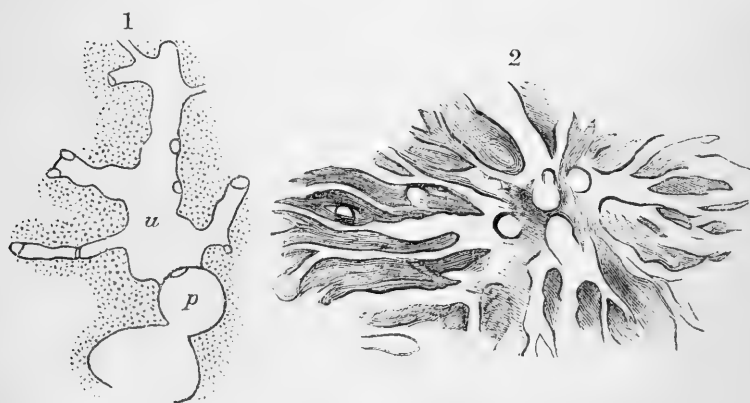
4. *The Water-canal System*.—The characters of the incurrent and excurrent ostial tubes have already been referred to; as they appear to represent the chones of other *Corticatæ*, it will be convenient to distinguish them as incurrent and excurrent chones. The two kinds of chones differ only in size, both being freely open distally and closed below by a sphincter, which protrudes downwards into a canal which here represents the crypt (Pl. XVII. figs. 1, 3, 20). Thus there is no endochone, and the chones are the equivalents of the ectochone alone.

The incurrent chone leads into a canal which extends parallel to the surface just below the rind for a variable distance, giving off one or more branches, which descend radiately into the interior, and break up into still smaller canals.



These canals are all exceedingly well defined, and all but the very smallest are provided with a distinct wall, which is transversely ridged by concentric rugæ. Short narrow canaliculi lead from the walls of these incurrent canals, main trunks, branches, and twigs alike, and open abruptly into the surrounding ciliated chambers. At a point generally opposite that at which the incurrent canaliculus enters, the ciliated chamber is gradually produced into an excurrent canaliculus, which is somewhat wider and less well defined than the corresponding incurrent vessel. The excurrent canaliculi join gradually together to form a trabecular tube, which, joining with others of a similar character, at length lead into a large canal with very definite and transversely rugate walls. This canal finally opens into an excurrent chone through a sphincter, and so communicates with the exterior.

There is a great difference in the way in which the ultimate canals of the excurrent and incurrent tubes are connected with the larger canals: in the former, as previously mentioned, the junction is gradual, the ultimate canals enlarging a little towards the point of junction, and then flowing together at an acute angle; in the latter the ultimate branches are given off abruptly and, remaining of about the same diameter, end abruptly; they also make rather a right than an acute angle with the larger branches. The figures of the annexed woodcut show the difference in character of the ultimate canals of the two systems very plainly.



1. The ultimate end (*u*) of an *incurrent* canal, proceeding from the penultimate branch (*p*), which is vesicular and provided with diaphragms to the end ( $\times 70$ ).
2. The ultimate ends of an *excurrent* tube gathering to form a penultimate trabecular tube, which has been cut across transversely.

*The Chones* (Pl. XVII. figs. 1, 3).—These, as well as the whole of the canal-system, with the exception of the ciliated chambers, are lined by a delicate epithelial layer.

Their walls are chiefly composed of concentrically arranged fusiform fibres, very similar to muscle-fibre, but staining much less intensely with carmine. Near the lower end of the chone this layer becomes continuous with the thick conical muscle which “plugs” the bottom of the chone and protrudes its apex into the subjacent crypt. The mass of the muscle consists of true, fusiform, muscular fibres concentrically arranged around a central canal, which is lined by epithelium and associated sharp-rayed stellates. The subcortical layer, where it joins the muscle, frequently dovetails with it, thrusting a small wedge of gelatinous connective tissue (*c*) into its side and receiving on its lower face a short superficial extension of the muscle-fibres, while its upper strictly fibrous portion (*f*) passes gradually into the muscle, the muscle having very much the appearance of being an over-development of the subcortical fibrous layer: this appearance is probably very near the truth, both structures having most likely been derived from a primitively indifferent fibrous layer, which on the one hand became modified into connective and on the other into muscular fibres. The chones are clearly the modified outermost vesicles of their associated canals, and their sphincters the modified rugæ of these canals. Hence the canal-walls contribute a share to the formation of the fibrous layer of the cortex.

*The Canals*.—The ultimate ramifications of the canal-system, as well as the smaller trunks into which they collect, are simple excavations in the mark lined by epithelium, which gives them, especially those having an incurrent function, a very sharp and definite outline. In the case of the larger canals the mark immediately surrounding them becomes a little less granular than elsewhere, and stains a little less deeply with carmine; hyaline fusiform fibres and sometimes granular fusiform cells appear in it, sometimes lying separate from each other, sometimes accumulated side by side and with overlapping ends forming a fibrous band. They are arranged both longitudinally and transversely with respect to the axis of the canal; but in the trabecular excurrent canals their position is governed by that of the trabeculæ, which they traverse more or less longitudinally. The structure of a canal-wall when fully developed exhibits, in transverse section, first, on the inside, a layer of epithelium, next a layer as much as 0.00125 inch thick of fibrous tissue, and then a layer of gelatinous connective tissue adjoining the mark.

The canals, especially the incurrent ones, are ridged transversely by circular rugæ, which are simply thin lamellar extensions of the wall, composed of epithelium and a small quantity of a tissue containing numerous very fine fibrillæ, which are arranged concentrically in each ruga and are slightly more abundant along its edge than elsewhere. The rugæ are often so greatly developed as to form iris-like diaphragms extending almost halfway across the canal; and as the canal is also constricted around the origin of the diaphragm, it thus becomes divided into a series of bladder-like compartments. This vesicular character occurs in many other sponges, but in none so markedly as in *Thena Wallichii*, which will be described subsequently. In *Isops* the vesicular character is most pronounced in the incurrent tubes, if not confined to them, and the rugæ or diaphragms likewise are chiefly characteristic of these tubes, occurring in all, from the largest down to those having a diameter of only  $\frac{1}{200}$  inch or less; in the excurrent tubes they are never so numerous nor extended so far across the canal, nor do they occur in tubes of such small diameter as in the incurrent system; it appears to me that they never occur in excurrent tubes unless of considerably over  $\frac{1}{100}$  inch diameter.

The physiological explanation of this difference in structure between the excurrent and incurrent tubes appears to lie in the fact that the water expelled into the former is under a slight excess of pressure, which is sufficient to keep them widely open; it is propelled by a *vis a tergo*. The water in the incurrent tubes, on the contrary, is drawn through them by a *vis a fronte*, and is thus under a slightly diminished pressure; they would therefore tend to be compressed by the water in the surrounding tissues; and it is possibly to prevent this that their walls are strengthened by the concentric rugæ.

*Ciliated Chambers* (Pl. XVII. fig. 23).—These organs are almost spherical in form and 0.001 inch in diameter; they consist of a structureless membrane, covered on the inner surface by roundish nuclei, surrounded by granular protoplasm, and disposed at very regular distances apart. Cilia proceed from these nucleated patches, radiating from the walls towards the centre of the chamber. They thus clearly represent, as far as they could be preserved, the collared cells of other sponges.

As previously mentioned, the ciliated chambers everywhere surround in close proximity the walls of the whole of the incurrent canals, large and small alike (Pl. XVII. fig. 27). Short narrow canals, usually about 0.0006 to 0.0009 inch long and 0.00025 inch in diameter, open abruptly into them and connect

them with the incurrent system. On the other hand they are gradually prolonged into the small ultimate canals of the excurrent system (Pl. XVII. fig. 25); they are the expanded ends of these canals, which unite together into larger trabecular tubes, having no direct communication with ciliated chambers, except that furnished by these tributary ultimate canals.

Herein lies the great distinction between the incurrent and excurrent system. The tubes of the former communicate directly at every part of their course with ciliated chambers; the tubes of the latter only communicate with the chambers at the end of their ultimate ramifications, just as a tree only bears leaves at the end of its twigs.

This observation, in connection with the difference in the mode of connexion (first pointed out by F. E. Schulze) of the excurrent and incurrent canaliculi with the ciliated chambers, is very suggestive. The cells of the ciliated chambers, together with the epithelial lining of the excurrent canals, are the adult representatives of the endoderm of the larval sponge; the epithelium of the incurrent tubes, together with the epidermis, are the descendants of the original ectoderm. In course of growth the ectoderm and endoderm have increased more rapidly than the intermediate tissue, which F. E. Schulze terms mesoderm; and the result has been an involution in two opposite directions—the endoderm developing like a racemose gland in one direction, the ectoderm undergoing a simpler involution in the other; such, at all events, appears to me the origin of the canal-system in *Isops* and *Geodia*.

Our observations might, however, be brought into accordance with Hæckel's theory of the canal-system, if we consented to regard our incurrent canals as forming an intervacular system, and the excurrent only as a genuine gastrovascular system. At the same time this is a purely theoretical view; and I cannot see how one reasonable man can blame another for choosing to consider the canal-system of such a sponge as *Isops* or *Geodia* as having a so-called "bipolar" arrangement, which, as a matter of observation, independent of all theory, it *has*. In saying this I am far from expressing any difference of opinion from Hæckel, whose general conclusions are clearly in the main correct, but simply desirous of adding my testimony to the value of Carter's observations, which are always faithful and accurate, and worthy a more generous estimate than that awarded them by his opponent.

While speaking of the canal system I would take the opportunity to point out the fact that the vesicular character of the incurrent canals is of a totally different nature from that described by Hæckel as distinguishing his "blasenförmige"

type of "Astcanäle" in the Leucones, and conjectured by him to exist also in the rind-sponges; one has but to compare the description given of this structure in the Leucones ('Die Kalkschwämme,' p. 235) with that given here as regards *Isops*, to see that there is no real resemblance between them.

### *Pathology.*

The exterior of the sponge is covered by various attached foreign bodies, such as young sponges, both calcareous and siliceous, minute Hydrozoa, Algæ, and Foraminifera. A small *Waldheimia* is also rooted into the sponge at one point, without apparently causing much harm. The larger attached Foraminifera are covered marginally by a thin brownish film, which has extended onto their upper surface from the dermis of the sponge. At its extreme edge this film only contains stellate spicules; but further on a few globates make their appearance. It would appear that the sponge is making, in these cases, an effort to overgrow and enclose the foreign bodies. On touching one of the Foraminifera with a sharp-pointed instrument, however, it separates from the sponge with the greatest facility, bearing with it on its under surface a number of attached globates, and leaving behind an irregular pit in the cortex. If the removed globates, or those immediately surrounding the pit left in the rind, be examined under the microscope, it will be found that they have entirely lost their fibrillar connective ligaments, which have degenerated into a quantity of granular material, probably of the nature of pus.

In the interior of the sponge foreign bodies also frequently occur—diatoms, Radiolaria, foreign sponge-spicules, Foraminifera (both calcareous and arenaceous), and the fibres of the *Waldheimia*-peduncle.

The siliceous inclusions and the fibres of the Brachiopod are simply imbedded in the mark, without producing or suffering any apparent change; the calcareous Foraminifera, however, lose the calcareous walls of their test by absorption, some kind of hyaline material taking their place; at the same time the mark surrounding the tests and filling their chambers becomes converted into gelatinous connective tissue.

Turning, again, to the foreign bodies of the exterior, one very singular case of commensalism remains to be noticed. A small Geodine sponge, only just escaped from the larval stage, has attached itself immediately over one of the incurant chones (Pl. XVII. fig. 1, *p*), and grown in such a manner that the terminal opening of its single branched excurrent tube is

exactly applied to the ostium of the incurrent chone of the *Isops*; and thus the supply of food and water brought to this particular chone can only reach it after straining through the intercepting parasite.

Should the association, which we may here regard as accidental, become permanent, great structural changes would probably be produced in the parasite: for one thing, the collared cells would be relieved of the necessity of propelling water through the organism, and could restrict themselves to gathering food for it; and no doubt this would lead to various other modifications. That in certain cases the association does become persistent is quite certain; for in a large specimen of *Ectyon sparsus* contained in the Bristol Museum we find a large number of the oscules lined each by a small parasitic *Geodia* belonging to an undescribed species; but as this specimen is unfortunately not preserved in spirits, we cannot determine the kind of histological change which may have been induced in it.

#### EXPLANATION OF PLATE XVII.

##### *Isops Phlegræi* (n. gen. et sp.).

- Fig. 1.* Section across the rind, showing an excurrent chone (E) and an incurrent chone with a young Geodine sponge (*p*) grown over its mouth: *f*, subcortical fibrous layer; *c*, gelatinous connective tissue ( $\times 15$ ).
- Fig. 2.* A long-shafted spicule enveloped in the spicule-sheath, *s*, and encircled by single, fusiform, hyaline fibres, *z* ( $\times 140$ ).
- Fig. 3.* Transverse section of the rind, showing incurrent chone with its sphincter protruding into the subjacent crypt ( $\times 15$ ). Canada-balsam preparation.
- Fig. 4.* Transverse section of lower part of rind: *g*, lowest-lying globates of globate layer; *f*, fibrous layer; *c*, gelatinous connective tissue with scattered fusiform fibres and an oval granular cell; *r*, rugæ of cryptal canal ( $\times 70$ ).
- Fig. 5.* Fusiform acerate spicule ( $\times 15$ ).
- Fig. 6.* Head of slender ternate spicule with recurved rays ( $\times 60$ ).
- Fig. 7.* Trifid spicule ( $\times 15$ ).
- Fig. 8.* Head of slender porrecto-ternate spicule, with only one ray developed ( $\times 60$ ).
- Fig. 9.* Bifurcated trifid spicule ( $\times 15$ ).
- Fig. 10.* Large stellate from the mark ( $\times 435$ ).
- Fig. 11.* Section across the dermal layer: *e*, epidermis; *d*, dermis, with intercalated stellates; *g*, outermost globates of the globate layer ( $\times 217$ ).
- Fig. 12.* Sphæro-stellate of the rind ( $\times 435$ ).
- Fig. 13.* Stellate of the mark, usual size ( $\times 435$ ).
- Fig. 14.* Outline of globate ( $\times 60$ ).
- Fig. 15.* A granular cell with terminal filament; from the gelatinous connective tissue of the subcortical layer ( $\times 435$ ).
- Fig. 16.* Similar to fig. 15, but without the extended filament ( $\times 435$ ).

- Fig. 17.* A fusiform hyaline fibre, showing a central cavity (nucleus) with a small spherule (nucleolus) ( $\times 435$ ).
- Fig. 18.* The hilum of a globate, with its contained nucleus. The nucleus exhibits a distinctly double contour, fluid contents, and a spherical nucleolus ( $\times 435$ ).
- Fig. 19.* A globate cell after treatment with dilute potash (5 per cent.), showing separated cell-wall and contained nucleus ( $\times 435$ ).
- Fig. 20.* Transverse section across rind and subjacent mark, showing an incurrent chone opening by a sphincter protruding into a rugose incurrent canal (*i*), and the smallest branches of the excurrent canal (*e*) terminating close to its walls ( $\times 7\frac{1}{2}$ ).
- Fig. 21.* A fragment of mark containing a granular mark-cell (*m*) and a globate cell (*s*) ( $\times 435$ ).
- Fig. 22.* The smallest or earliest stage of globate yet observed ( $\times 435$ ).
- Fig. 23.* A ciliated chamber ( $\times 435$ ).
- Fig. 24.* The tubercular surface of a globate, seen face on, showing the large axial canals perforating the tubercles ( $\times 435$ ).
- Fig. 25.* Longitudinal section of the terminal branch of an excurrent canal (*e*) with its canaliculi ending in ciliated chambers: *i*, the ultimate branch of an incurrent canal supplying the ciliated chambers ( $\times 157$ ).
- Fig. 26.* An iris-like diaphragm from one of the rugose incurrent tubes, seen face on ( $\times 60$ ).
- Fig. 27.* Transverse section of an incurrent tube, from which canaliculi proceed and enter the ciliated chambers ( $\times 204$ ).

[To be continued.

### XXXVIII.—*New Genera and Species of Coleoptera from Madagascar.* By CHARLES O. WATERHOUSE.

A COLLECTION of Coleoptera recently received at the British Museum from Madagascar has brought to light several new species, which I here describe, with some also which were received from former collections.

#### Cetoniidæ.

##### *Parachilia compacta*, n. sp.

Nigra, opaca; elytris obsolete punctatis, marginibus obscure piceis; pedibus nitidis. ♂, ♀.

Long. 13 lin.

Very close to *P. bufo*, G. & P., but differs in being considerably shorter, less narrowed posteriorly, and with the elytra apparently constantly margined with purple-pitchy colour. The legs are shorter, and the difference in the length of the tarsi is very great in the male; in *P. bufo* the posterior tarsi are longer than the tibiæ by the two apical joints, whereas in *P. compacta* the tarsus is only about half the apical joint longer

than the tibia. The pubescence on the intermediate tibiæ of the male is much less.

*Hab.* Fianarantsoa (*Rev. W. Deans Cowan*).

### Prionidæ.

#### *Macrotoma obscura*, n. sp.

Nigra; capite thoraceque fortiter rugosis, hoc angulis posticis spina acuta armato; elytris coriaceis, basi granulis minutis crebre aspersis, apice picescente, femoribus tibiisque fortiter spinosis. ♂.  
Long. 22 lin.

Resembles *M. serripes*, Oliv., but with much less rugose elytra. Antennæ as long as the elytra and half the thorax; the first joint oblong, twice as long as broad, very rugose, and with a few short spines on the margins; the third joint a little narrowed towards its apex, coarsely punctured and beset with very short spines; the four following joints smooth, sparingly punctured; the apical joints opaque, longitudinally rugose. Thorax very coarsely rugose, convex, obliquely narrowed anteriorly, the sides with numerous short strong spines, the posterior angle furnished with a strong, acute, recurved spine, the base strongly bowed in the middle. Elytra a very little narrowed behind the middle, coriaceous, sparingly beset with stiff yellowish hairs, the base closely beset with minute round granules, the sutural angle with a short strong spine. Femora and tibiæ furnished with strong spines on their edges, rather close together; the anterior tibiæ very flat, rugose, the edges closely spinose. Abdomen pitchy.

*Hab.* Antananarivo.

#### *Macrotoma læta*, n. sp.

Obscure picea; capite thoraceque rugosis, flavo pilosis, hoc lateribus acute spinosis, angulis postice acute productis; elytris fulvo-ferrugineis, dense rugulosis, apice obtuso. ♀.  
Long. 20 lin.

Antennæ three quarters the length of the elytra; the basal joint subcylindrical, a little narrowed at the base, rather thickly punctured; the third joint cylindrical, smooth, sparingly punctured; the fourth to seventh joints becoming more closely punctured; the apical joints dull, longitudinally rugulose. Thorax densely and evenly rugulose, convex, impressed on each side of the disk, strongly spinose at the sides, which are slightly arcuate, the posterior angles produced into a strong acute spine; the base strongly arcuate. Scutellum moderately punctured. Elytra parallel, pale pitchy, closely



rugulose, without costæ, the extreme suture pitchy, the sutural angle with a very small spine. Legs irregularly and sparingly spinose, the anterior femora not spined above; all the tibiæ with rasp-like punctures, the four posterior tibiæ not spined on the inner margin.

*Hab.* Fianarantsoa (*Mr. Shaw*).

*Macrotoma asperata*, n. sp.

Fusco-picea, obscura; capite thoraceque confertissime rugoso; elytris creberrime minute tuberculatis, sutura spina parva acuta.

Long. 15–17 lin.

♂. Head densely rugose, with an impressed frontal line; the eyes widely separated. Antennæ the length of the elytra, the basal joint rather large, not much narrowed at the base, thickly rugose; third joint as long as the two following taken together, rather closely asperate-punctate, except at the apex; the fourth to ninth joints more slender, shining, rather sparingly punctured, the tenth and eleventh joints longitudinally finely rugulose. Thorax convex, densely and strongly rugose, transverse, obliquely (but not much) narrowed anteriorly, the margins crenulate, the posterior angles with a distinct acute (but not very prominent) tooth; the base arcuately lobed in the middle, and with a very slight emargination just before the posterior angle. Elytra subparallel, opaque, *very* slightly narrowed at the apex, thickly studded all over with minute shining tubercles, especially conspicuous near the base. The sutural angle has a distinct acute spine. Legs compressed, the femora and tibiæ rather thickly studded with minute shining tubercles, the posterior femur more smooth; the anterior tibiæ are not properly spinose; but on the underside of the outer edge may be seen a few small teeth. The four posterior legs are very similarly sculptured. The fifth segment of the abdomen is widely and rather deeply emarginate.

♀. This differs from the foregoing in having the antennæ a little shorter; the basal joint is less robust, strongly punctured; the third to sixth joints are shining, sparingly punctured; the third joint quite as long as the fourth and fifth taken together; the seventh is rugulose at the apex, and the eighth to eleventh are opaque, longitudinally very finely and closely strigose. The posterior angle of the thorax is produced into a strong acute spine; the sides are scarcely crenulate. The fifth segment of the abdomen is nearly truncate, scarcely sinuate in the middle. The legs are more slender, shining, sparingly asperate-punctate.

*Hab.* Antananarivo (*Mr. Kingdon*).

*Macrotoma vicina*, n. sp.

♂. Very close to *M. asperata*, but with shorter antennæ and elytra, and acute anterior angles to the thorax. Antennæ the same length as the elytra; the basal joint closely and very coarsely rugose-punctate; the third joint as long as the fourth, fifth, and one third of the sixth taken together, rather strongly but not very thickly punctured, a little thicker at each end than in the middle; the following joints slender, the fourth to ninth very sparingly punctured, the base and apex of the tenth joint and the whole eleventh joint longitudinally channelled and opaque. Eyes widely separated as in *M. asperata*. Thorax rather less convex, very coarsely rugose, the anterior angles slightly prominent and dentiform; the sides scarcely crenulate, slightly bowed out a little behind the middle; the posterior angles with an acute slightly prominent tooth. Elytra thickly studded with minute tubercles or granules. Anterior femora rather thickly tuberculate-rugose, the posterior pair not very thickly punctured, smooth above; the anterior tibiæ opaque, moderately thickly beset with minute granules; the posterior tibiæ moderately thickly punctured. Some few, very small, sharp tubercles may be seen on the underside of the femora.

The elytra of the specimen above described are pale yellow; but this is, I think, evidently from immaturity.

♀. This differs from the female of *M. asperata* in having the elytra relatively shorter; and the tuberculation of the elytra is rather more distinct. The third joint of the antennæ is the same length as in the foregoing species; but, the following joints being shorter, it is nearly as long as the fourth, fifth, and sixth joints taken together; the eighth and ninth joints have elongate punctures; the tenth and eleventh joints are short, shining, and longitudinally coarsely grooved; the three apical joints together are scarcely as long as the third joint. The sides of the thorax are furnished with short, strong, acute spines. The fifth segment of the abdomen is distinctly (but not deeply) emarginate in the middle.

*Hab.* Antananarivo (*Mr. Kingdon*).

*Macrotoma Pfeifferæ*, n. sp.

♀. Most nearly resembles the female of *M. asperata*, but is of a paler pitchy-brown colour, altogether of a more elongate slender build, with the base of the antennæ and the femora of a clear reddish brown. Antennæ slender, the same length as the elytra; the basal joint thickly and rather strongly punctured, more elongate than in *asperata*; the third joint

very slender, as long as the two following joints taken together, rather closely and obscurely punctured; the fourth, fifth, and sixth joints more distinctly and moderately thickly punctured; the seventh more finely punctured; the eighth to eleventh joints closely and longitudinally strigose; the three apical joints together equalling the third joint in length. Head closely rugose; the eyes large and approximate, their distance above about equal to two thirds the upper part of the eye; in *M. asperata* ♀ the distance is about one third greater than the width of the upper part of the eye. Thorax densely rugose, the margins with a few irregular crenulations, the posterior angles produced into a very acute spine. Elytra very long, subparallel, opaque, rather thickly punctured, the punctures round and lightly impressed, the base thickly studded with minute shining granules; each elytron with three fine costæ, and with a trace of a short fourth one near the apex, the space between the costæ flattened, or even slightly concave posteriorly; sutural angle furnished with a stout acute spine, which turns slightly outwards. Femora sparingly and obscurely punctured; the tibiæ slightly dull and finely punctured; tarsi rather long and slender. Fifth abdominal segment truncate at the apex.

*Hab.* Madagascar (*Madame Ida Pfeiffer*).

*Macrotoma sodalis*, n. sp.

♀. Head very strongly rugose-punctate; the distance between the eyes nearly equal to the width of the upper part of the eye. Antennæ not quite so long as the elytra; the basal joint not very large, rather closely and strongly punctured; the third joint as long as the two following taken together; the third to sixth joints sparingly punctured; the seventh and eighth joints with a strigose spot at the apex; the apical half of the ninth and the whole of the tenth and eleventh joints longitudinally channelled, opaque; the three apical joints together as long as the third and half the fourth together. Thorax closely and strongly rugose-punctate, the sides with two or three very short acute teeth, or without any; the posterior angle furnished with a slender very acute spine. Elytra long, widest behind the middle, and then a little narrowed to the apex, coriaceous, the base somewhat closely (but not very strongly) rugulose; near the scutellum are some minute granules or tubercles; the sutural angle has a conical acute spine. The femora are rather sparingly punctured, the anterior pair with a few very acute spines below; the four posterior femora have a few, acute, thorn-like spines above and below; the tibiæ are finely longitudinally wrinkled,

furnished with a few acute thorn-like spines on both their edges; tarsi rather slender. Fifth segment of the abdomen slightly triangularly emarginate.

*Hab.* Fianarantsoa (*Rev. W. Deans Cowan*).

*Macrotoma mutica*, n. sp.

Most nearly allied to *M. sodalis*, but with shorter antennæ and pale brown elytra, with no spine at their sutural angle. Antennæ not quite the length of the elytra; the basal joint not very large, narrowed towards its base, strongly but not very thickly punctured; the third joint as long as the two following joints taken together, sparingly punctured; the fourth and fifth similarly punctured; the sixth and seventh more finely punctured; the eighth to eleventh opaque, longitudinally finely channelled; the three apical joints together as long as the third and fourth joints together. Head very coarsely rugose-punctate; the distance between the eyes about equal to the width of the upper part of the eye. Thorax very convex, densely and strongly rugose-punctate; the sides irregularly crenulate; the posterior angles produced into a strong acute spine, which is broad at its base. Elytra subparallel, pale yellowish brown, without costæ, rugulose, a little more strongly so near the scutellum. Femora finely and not very thickly punctured; tibiæ less shining and rather more punctured, with one or two acute spines on the outer edge. The fifth segment of the abdomen distinctly emarginate at the apex.

*Hab.* Fianarantsoa (*Mr. Shaw*).

*Macrotoma Wrightii*, n. sp.

♂. Nearly black, with the elytra dark brown posteriorly, the tarsi pitchy. Head very rugosely punctured, closely asperate-punctate posteriorly. Antennæ a little longer than the whole insect; the basal joint large, closely and coarsely asperate-rugulose; the third joint very long, as long as the fourth, fifth, and two thirds of the sixth taken together, densely and very coarsely asperate; the fourth to seventh joints sparingly punctured, the fourth with a few asperities; the eighth and ninth joints more thickly punctured, especially the ninth; the tenth and eleventh still more densely punctured, the eleventh with a mixture of short longitudinal channels. Thorax as long as its width in front, a little more than one third broader at the posterior angles than at the anterior, densely and coarsely rugulose, with a slight swelling on each side of the disk, and with some yellowish pubescence on each side of the base; the anterior margin trisinuuous; the

sides with irregularly disposed tubercle-like teeth; the region of the posterior angle is somewhat swollen, the angle itself produced (slightly backwards) into an acute process; the base very slightly sinuous (nearly straight) in its middle portion, but rather strongly sinuate behind each posterior angle. The elytra are parallel, very slightly narrowed at their apex, convex at the base, depressed posteriorly; very strongly, closely, and rugosely punctured at the base; the rest of the surface, although strongly and closely punctured, is not so strongly sculptured as the base; each elytron has an obtuse ridge near the suture, rising before the middle of the elytron and terminating before the apex; there is a somewhat more marked fold near the margin, rising near the shoulder and extending nearly to the apex; the space between these ridges is nearly flat (with an indication of a third short ridge in the middle); the side beyond the lateral ridge is suddenly deflexed; the sutural angle is slightly dentiform. The legs are long; the anterior femora and tibiæ very rough and closely beset with small shining tubercles, which on the edges of the tibiæ form small teeth; the underside of the femora is transversely rugulose; the other legs are not so rough, and the base of the femora is nearly smooth. The fifth segment of the abdomen is very slightly sinuate in the middle.

*Hab.* Seychelle Islands.

A single specimen presented by Dr. E. P. Wright.

### Lepturinae.

#### *Artelida asperata*, n. sp.

Nigra, subtilissime griseo-pubescens; oculis fortiter granulatis; thorace medio rugoso, quadrituberoso, lateribus dente conico armatis; elytris dorsaliter paulo impressis, regione basali granuloso-punctatis; antennis, tibiis tarsisque piceis.

Long. 6-8½ lin.

Rostrum very short. Eyes prominent and strongly granular, moderately separated below and above. Thorax moderately transverse, constricted in front, rather thickly and rugosely punctured, with four distinct tumours on the disk; the lateral tubercle prominent, conical. Elytra not much narrowed posteriorly, finely coriaceous, with the basal region moderately thickly punctured with horseshoe punctures, the apex of each elytron obtuse; there is a slight costa-like fold running obliquely from the shoulder, not extending to the apex. The claw-joint of the male is much dilated at the apex.

*Hab.* Antananarivo (*Mr. Kingdon*).

A very distinct species, on account of the granular punctuation at the base of the elytra.

*ÆDÆUS*, n. gen.

Antennæ slender, filiform. Eyes moderately coarsely granular, rather widely separated. Thorax obliquely narrowed in front of the middle, with two small tumours on the hinder part of the disk; lateral tubercle very little prominent, obtusely conical. Elytra evenly convex, moderately narrowed posteriorly, without costæ, the margins very narrowly incrassated.

The general appearance of the species upon which I propose to establish this genus is that of *Acmæops*; but the structure of the head and thorax approaches *Logisticus*. The finely incrassated margin to the elytra, replacing the narrow epipleural fold (found in *Logisticus* &c.), is one of the chief characters.

The genus should follow *Artelida*.

*Ædæus geniculatus*, n. sp.

Capite, thorace supra, scutello genibusque nigris, ceteris piceo-testaceis, elytrorum sutura apiceque infuscatis.

Long. 5 lin.

Head and thorax clothed with yellowish-grey pile, very fine and not very dense. Thorax as long as its greatest width, thickly and excessively finely punctured, constricted in front of the middle, subparallel behind the lateral tubercle, which is not very prominent and is obtusely conical; the disk evenly convex in front, furnished posteriorly with two distant, small, round, slightly raised tumours. Elytra at the base not quite twice as broad as the base of the thorax, moderately narrowed behind, obtuse at the apex, delicately pilose, very densely and extremely delicately punctured.

*Hab.* Antananarivo (*Mr. Kingdon*).

*Logisticus suturalis*, n. sp.

Fuscus, griseo-sericeus; thorace quadrituberoso, lateribus tuberculo obtuse conico instructis; elytris apicem versus modice angustatis, sutura bene determinata, apice truncatis.

Long. 10–12 lin.

Somewhat intermediate in form and appearance between *Artelida sericea*, Guérin (Ic. Règne An. p. 252, *Toxotus*), and *Logisticus rostratus*, Waterh. (Cist. Ent. ii. 1878, p. 291); its affinities, however, are with the latter, with which it

agrees in having very coarsely granular eyes. Rostrum a little broader than long, a very little narrowed at the base. Eyes prominent, rather approximate above, especially in the male. Thorax constricted in front, nearly parallel behind, with four, round, slightly raised tumours above, with an obtuse slightly prominent tubercle at the side. Elytra longer than in *A. sericea*, but not so long as in *L. rostratus*, truncate at the apex, the sutural angle scarcely dentiform; each elytron has a somewhat oblique, broad but scarcely raised costa, nearly similar to that of *A. sericea*, which is absent in *L. rostratus*. The suture is narrowly incrassated, and very clearly marked. The claw-joint of the male is extremely narrow at the base, dilated at the apex.

*Hab.* Fianarantsoa (*Rev. W. Deans Cowan*).

*Logisticus angustatus*, n. sp.

Elongatus, angustus, nigro-fuscus, subtiliter pilosus; rostro elongato; elytris brunneis, haud costatis, apice truncato, haud emarginato.

Long. 8-10 lin.

Very close to *L. rostratus*, W., but smaller and with more decidedly brown elytra. The rostrum is a little narrower; the eyes are large and prominent, very coarsely granular, very approximate above, almost contiguous above and below in the male. Thorax evenly convex, with four scarcely noticeable dorsal tumours; constricted in front, with a small obtuse tubercle at the side. Elytra very elongate, gently and evenly convex, without costæ, narrowed towards the apex, which is slightly truncate, the angles of the truncature not prominent. Claw-joint of the male much dilated at the apex.

*Hab.* Antananarivo (*Mr. Kingdon*).

*Logisticus simplex*, n. sp.

Fuscus, subtiliter griseo-pubescent; rostro vix brevius quam latius; elytris leviter convexis, haud costatis, apice haud truncato. ♂.

Long. 6 lin.

Very like *L. angustatus*, but not quite so elongate. The rostrum is shorter and broader, scarcely as long as broad. The eyes are prominent and coarsely granular, moderately approximate above, a little more separate below. Elytra brown, evenly convex, not much narrowed posteriorly; the apex of each elytron slightly rounded.

*Hab.* Antananarivo (*Mr. Kingdon*).

*Logisticus obscurus*, n. sp.

Fusco-niger, subtiliter griseo-pubescens; rostro vix longiore quam latiore; elytris leviter convexis, haud costatis, apice ipso truncato, angulo externo producto. ♀.

Long.  $8\frac{1}{2}$  lin.

This has almost completely the form of *L. simplex*, but is of a uniform blackish-fuscous colour, the antennæ, tibiæ, and tarsi brownish. The rostrum is not quite so short (not so long as in *rostratus*); and the eyes are almost contiguous below, moderately separated above. The apex of the elytron is a little truncate, with the external angle distinctly produced.

*Hab.* Antananarivo (*Mr. Kingdon*).

## APPEDESIS, n. gen.

Antennæ very slender, widely separated. Eyes prominent posteriorly, not supported behind by any cheek. Thorax evenly convex, arcuately narrowed anteriorly in front of the middle, with no lateral tubercle. Elytra not costate, moderately narrowed posteriorly, slightly truncate at the apex. Intermediate as well as anterior coxæ very prominent. Posterior tarsi not very elongate, the third joint bilobed.

The general appearance of the species for which I propose this genus is that of some species of *Leptura*; but the slender antennæ, the eyes not supported behind by any cheek, and the shorter tarsi induce me to separate it. The posterior tarsi are especially relatively less long, less compressed, and the third joint is broader, strongly bilobed. It should be placed before *Leptura*.

*Appedesis vidua*, n. sp.

Sordide flava; capite abdomineque nigris, thorace ferrugineo-rufo, scutello piceo; elytris fusco-nigris, fascia lata basali utrinque vittam elongatam emittente sordide flava.

Long.  $3\frac{1}{2}$  lin.

Head black, clothed with greyish-yellow pile, very closely and finely punctured; flat in front, the antennal tubercles depressed. Eyes finely granular, completely free and prominent posteriorly. Thorax dull red, as long as broad, gently convex, with very short yellowish pile, densely and rather finely punctured, a little narrowed in front of the middle, subparallel posteriorly, the extreme base margined with black. Elytra about one third broader than the thorax, moderately narrowed posteriorly, slightly truncate at the apex, clothed with very short, not very dense, yellow pile; moderately, thickly, and



distinctly punctured; pitchy yellow, the extreme base black, the apical two thirds blackish fuscous, with a sublateral pitchy-yellow stripe (emitted from basal yellow portion), not extended to the apex. The apical spines of the tibiæ and the claws nearly black.

*Hab.* Antananarivo (*Mr. Kingdon*).

### Leptocerinae.

#### *Leptocera lineatopunctata*, n. sp.

Nigra: thorace crebre fortiter punctato, lineis quatuor albo-pilosis; elytris obscure cyaneis vel purpureis, fortiter lineato-punctatis, apice truncato, sutura alba.

Long.  $4\frac{1}{2}$ –5 lin.

Head closely and very strongly punctured, with white pile on the sides of the face and cheeks. Thorax subcylindrical, very slightly narrowed in front and at the base, densely and strongly punctured; with four narrow white silky streaks above. Elytra not very much narrowed posteriorly, obscure purple or deep steel-blue, with lines of very strong punctures; the punctures are rather smaller towards the apex; the apex of each elytron is truncate, the outer angle being slightly dentiform. The mesothoracic epimera and the metathoracic parapleuræ are pitchy. The femora are rather strongly clavate.

*Hab.* Antananarivo (*Mr. Kingdon*).

This species is allied to *L. humeralis*.

### XXXIX.—*New Neotropical Curculionide*.—Part I.

By FRANCIS P. PASCOE, F.L.S. &c.

As a large number of undescribed Tropical-American Curculionidæ are to be found in collections, I purpose to describe some of the more remarkable, though not necessarily those most distinguished for size or beauty. My own collection contains a goodly number derived from various sources, especially from Parana, a province south of Rio de Janeiro, and very little known entomologically, forming part of the collection of the late lamented Mr. W. W. Saunders, and obtained, I believe, by Mr. Chesterton. There are also many species from Mr. Bates (Para and the Amazon valley), Mr. Buckley (Ecuador), Mr. E. Bartlett (Eastern Peru), Mr. E. Janson (Chontales), and others, including a large number from M. James Thomson's collection, chiefly from French collectors

in Guiana, Columbia, Panama, Mexico, &c. These latter bear in many cases the MS. names of MM. Buquet, Laferté, Chevrolat, Jekel, and the Comte Dejean.

Of late years the only descriptions of these New-World tropical insects are those of Dr. Kirsch, and MM. Chevrolat and Jekel; but they are not very numerous.

The species described in this part, and the subfamily to which they belong, are:—

## BRACHYDERINÆ.

*Platyomus ostracion*.

*Curiades*, n.g. for *Platyomus* Boisduali, Boh.

*Cyphus effusus*.

— *sigillatus*.

*Trichaptus*, n.g. for *Rhigus myrmosarius*, Perty.

*Ericydeus*, n.g. for *Cyphus Hancockii*, Kirby.

*Compsus vestalis*.

— *mirandus*.

*Compsus virgineus*.

— *vespertinus*.

— *euchloris*.

*Eustales coruscus*.

— *cometes*.

— *stellaris*.

— *sejunctus*.

— *interruptus*.

— *impositus*.

*Brachyomus metallescens*.

*Clæoteges*, n.g.

— *virusus*.

*Platyomus ostracion*.

*P. oblongus*, densissime supra umbrino-, lateraliter albido-squamulosus; prothorace cylindrico, elongato; scutello oblongo, postice ampliato; elytris bifariam seriatim punctatis, lineis tribus elevatis tuberculatis instructis; apicibus mucronatis. Long. 9 lin.

*Hab.* Brazil.

Oblong, closely covered above with umber-brown scales, the sides and beneath whitish; rostrum much broader at the apex, a short median line extending to a fovea on the front; antennæ stout, setulose, the club small, brown; prothorax cylindrical, much longer than broad, deeply and irregularly pitted; scutellum narrow and linear anteriorly, expanded behind; elytra broadest at the shoulder, abruptly declivous behind, the sides moderately rounded, strongly punctured in double rows, the raised lines between, but not extending, except the first, to the declivous portion, tuberculate, the first or inner line with the tubercles more strongly developed, the last tubercle spiniform and horizontal; legs setulose, brownish, mottled.

Allied to *P. niveus*, but narrower, less strongly tuberculate, and differently coloured.

## CURIADES.

*Rostrum* breviusculum, apice leviter emarginatum, supra ad frontem late et profunde excavatum. *Scapus* antennarum brevis, apicem versus incrassatus, ad marginem posticum oculi vix attingens. *Prothorax* parvus, transversus. *Elytra* ampliata, pilis longis-

simis erectis oblecta. *Abdomen* sutura prima angulata. *Corpus* pilosum.

This genus is proposed for *Platyomus Boisduvali*, Boh., a very remarkable hairy form, which, as a *Platyomus*, has long been an opprobrium to our classification. The characters which separate it from that genus, however, are, when viewed in relation to the heterogeneity of its species, somewhat feeble; the principal relate to the rostrum, which is only slightly emarginate at the tip, and is deeply and broadly excavated as far as the eyes, the boundaries of the hollow on each side being raised into a prominent ridge or crest. One thing is quite certain, that this species has only a very distant affinity with any *Platyomus*.

*Cyphus effusus*.

*C. ovatus*, dense cretaceo-squamulosus, supra viridescenti-undulatus; prothorace transverso; elytris irregularibus, apicibus rotundatis, haud productis. Long.  $6\frac{1}{2}$  lin.

*Hab.* Macas.

Ovate, covered with cretaceous scales, tinted above with pale green arranged in waved crossed bands; head, antennæ, and legs spotted with black setulose scales; rostrum deeply excavated between the antennæ, an impressed line continued to the head; prothorax very short, the sides, except at the apex, nearly parallel, a broad excavation along the base; scutellum triangular; elytra uneven, owing to the irregularity of the raised interstitial lines, the intervals with a double row of impressed punctures, the apices rounded and not produced. Body beneath with a pale greenish tinge.

This and the following species differ from the rest of the genus in having a very short prothorax, with the sides, except just at the apex, parallel.

*Cyphus sigillatus*.

*C. ovatus*, dense cretaceo-squamulosus, pone medium elytrorum fascia maculata et maculis duabus posticis notatus; prothorace transverso; elytris supra paulo depressis, apicibus rotundatis haud productis. Long.  $6\frac{1}{2}$  lin.

*Hab.* Para.

Ovate, covered with cretaceous scales, having a very slight tint of green or grey; head, antennæ, and legs spotted with black setulose scales; rostrum broadly excavated between the antennæ, an impressed line continued to the head; prothorax very short, nearly parallel at the sides, but a little contracted anteriorly, a broad excavation along the base; scutellum triangular; elytra rather short, depressed above, the interstices scarcely raised, the punctures small, in not very regular lines,

the apices rounded and not produced, behind the middle a band of black spots, those near the suture partially coalescing, an irregular spot posteriorly, and a smaller one near the shoulder.

Allied to *C. effusus*, but different in coloration and sculpture of the elytra. The difference between *Cyphus* and *Platyomus* is not well marked. Germar included the species known to him under the former name; and both genera contain species which, from their outward appearance, would not be supposed to have any generic affinity. *Compsus* was first separated as a genus from *Platyomus* by Lacordaire; among other minor characters, it is best distinguished by the mucronate anterior tibiæ. To *Cyphus* I refer those forms which have the rostrum not enlarged at the tip as in *Platyomus*, lateral scrobes, and a more slender scape. A remarkable form bearing a strong resemblance to a *Mutilla* (Hymenoptera) was proposed to be generically separated by Germar under the name of *Trichaptus*; but the genus was never published. It was first described as a *Rhigus* by Perty (*R. myrmosarius*). It is, I think, a far better genus than many others whose claims have never been questioned. The following are its principal characters:—

#### TRICHAPTUS.

*Caput* transversum. *Rostrum* breviusculum, capite multo angustius; scrobe ab insertione antennæ, transversa, oculum tangente. *Prothorax* gibbosus, basi quam medio angustior. *Elytra* elevata, valde convexa. *Cætera* ut in *Cypho*.

The essential character of this genus is in the direction of the scrobe, which, beginning near the mouth, takes a sudden bend and passes transversely beneath the eye, which, indeed, forms part of its upper boundary. The only species was subsequently named by Boheman *Cyphus Linnei*, after “the first of naturalists, past, present, and future.” But, then, this was in 1833.

There is another species which, as Lacordaire has pointed out, should be also separated from *Cyphus*. It is the *Cyphus Hancockii* of Kirby, one of the handsomest of the Curculionidæ. It differs in having the anterior tibiæ mucronate as in *Compsus*, and in the grooved lower and hind margin of the posterior and intermediate tibiæ, which is also densely ciliated. The principal characters of this genus, for which I propose the name of *Ericydeus*, are as follows:—

#### ERICYDEUS.

*Caput* haud latius rostro. *Antennæ* articulo primo funiculi perbrevis. *Tibiæ* anticæ mucronatæ, intermediæ et posticæ extus

apicem versus inciso-sulcatæ, ciliatæ. *Coxæ* posticæ magis approximatæ. Cætera ut in *Cypho*.

*Compsus vestalis*.

*C. oblongus*, squamulis albis, aliis læte viridibus intermixtis, densissime vestitus; capite, antennis pedibusque squamulis aureo-opalescentibus tectis; rostro in medio lineato-impresso; scapo valido. Long.  $6\frac{1}{2}$  lin.

*Hab.* Macas.

Oblong, closely covered with white mixed with bright green scales, the whole apparently pale green; head, antennæ, and legs opalescent, covered with golden scales having a slight rose tint; scape of the antennæ rather short, stout; head and rostrum with a slightly impressed median line; prothorax slightly broader than long, the sides not rounded, sparsely punctured, a shallow longitudinal impression, the base bisinuate; scutellum small, roundish; elytra a little broader behind the middle, the apices divaricate, striate-punctate, the interstices raised, the punctures double-rowed.

In coloration agreeing to a certain extent with *C. auricephalus* (Say), but, *inter alia*, without the slender scape of the latter.

*Compsus mirandus*.

*C. elongato-ovatus*, squamulis læte aureo-viridibus, maculis denuclatis nigris elytrorum exceptis, dense tectus; rostro modice robusto; elytris postico angustatis, singulatim apice productis. Long. 7 lin.

*Hab.* Columbia.

Narrowly ovate, covered above and beneath with rich golden-green scales, the vertex with two, the elytra with several round black naked spots; antennæ slender, the funicle rather long, the club darker; prothorax longer than broad, the base bisinuate; scutellum expanded behind; elytra not much produced at the shoulders, narrower posteriorly, each ending in a prolonged apex; knees and tibiæ with a slight bluish tint.

A handsome species, with no near ally, so far as I know, except the preceding.

*Compsus virgineus*.

*C. oblongus*, densissime cretaceo-squamosus; antennis, genibus tarsisque pallide cæruleis; scutello transverso; elytris bifariam seriatim punctatis. Long.  $7\frac{1}{2}$  lin.

*Hab.* Trinidad (Peru).

Oblong, densely covered above and beneath with pure

chalky-white scales; the antennæ, knees, and tarsi with a pale bluish tint; rostrum with a fine impressed longitudinal line; antennæ slender, the club blackish; prothorax slightly transverse, a few scattered irregular punctures; scutellum subquadrate, transverse; elytra convex, a double row of small punctures between each raised interstice, the apices slightly produced, divaricate.

Among the white members of the genus this species may be distinguished by its subquadrate transverse scutellum, convex elytra, and purer colours.

*Compsus vespertinus.*

*C. sat* late oblongus, haud depressus, squamulis albidis dense tectus; rostro capiteque supra et medio prothoracis pedibusque, basi femorum excepta, læte aureo-cupreis; antennis tenuibus; scutello oblongo. Long. 8 lin.

*Hab.* Sarayacu, Chamicuros.

Rather broadly oblong, not depressed above, covered with nearly pure white scales; rostrum and head above, middle of the prothorax and legs, except the bases of the femora, more or less of a bright copper with a golden tint; antennæ slender, darker towards the club; rostrum with a deep impression in the middle, and another on each side; prothorax above equal in length and breadth, irregularly and sparsely punctured, bisinuate at the base; scutellum oblong; elytra convex, a double row of moderate-sized punctures between each raised interstice, the apices produced, scarcely divaricate.

In one of my specimens the copper-colour does not extend to the prothorax. *C. lacteus* (Fab.), depressed above, with blue legs &c., may be considered an ally.

*Compsus euchloris.*

*C. elongato-ovatus*, densissime læte viridi-squamosus; rostro supra convexo, integro; scutello minuto; elytris seriatim punctatis, postice bituberosis, apicibus paulo productis. Long. 8 lin.

*Hab.* Sarayacu.

Oblong ovate, closely covered with fine, mostly opaque, pure green scales, but with numerous golden scales intermixed; antennæ and tarsi cobalt-blue; rostrum convex above, without any impressed line; antennæ slender; prothorax rather longer than broad, irregularly pitted above; scutellum very small; elytra a little flattish above, each with a well-marked gibbosity posteriorly, the apices slightly produced, linearly punctate, the punctures small and shallow.

In form resembling *C. mirandus*, but, *inter alia*, without the black naked spots on the elytra.

*Eustales coruscus.*

*E. elongato-ovatus*, squamulis aureo-viridibus fere omnino dense tectus; pedibus rostroque in medio cæruleis; elytris postice sat abrupte declivibus, apicibus acutis haud productis. Long.  $5\frac{1}{2}$  lin.

*Hab.* Macas.

Narrowly ovate; body almost entirely covered with rich golden-green scales; antennæ, median line on the head, continued partially on the prothorax, and legs, except the base of the femora, cobalt-blue, club of the antennæ with a greyish pubescence; rostrum not carinate; prothorax about equal in length and breadth, rounded at the sides, the anterior half with a deep longitudinal impression and a shallow V-shaped depression posteriorly, the base straight; scutellum small, rounded, blackish, pubescent; elytra rather strongly punctured, not striated, slightly depressed above and rather abruptly declivous posteriorly, and without gibbosities, the apices pointed but not produced.

Allied to *E. opulentus*, Boh., which, *inter alia*, has the rostrum and legs gold-coloured, and the base of the prothorax bisinuate. It differs from the following in the colour of its legs, the absence of gibbosities on the elytra, &c.

*Eustales cometes.*

*E. elongato-ovatus*, squamulis aureo-viridibus omnino dense tectus; scutello nigro, triangulari; elytris postice sat subito declivibus, singulatim gibbosis. Long. 5 lin.

*Hab.* Macas.

Narrowly ovate, entirely covered, except the scutellum, with bright golden-green scales, including the antennæ, but the club black; rostrum not carinate; prothorax rather longer than broad, slightly bisinuate at the base, the disk with three punctiform depressions; scutellum triangular, black; elytra broadest at the shoulders, depressed above, strongly punctured, declivous, each with a well-marked gibbosity posteriorly; the apices slightly divaricate.

This and the preceding are very brilliantly coloured species; under the lens purely golden scales are seen amongst the green ones.

*Eustales stellaris.*

*E. elongato-ovatus*, nitide niger, maculis aureo-viridibus adpersus; rostro sat elongato, in medio linea paulo elevata; elytris modice convexis, regularibus. Long.  $5\frac{3}{4}$  lin.

*Hab.* Panama.

Narrowly ovate, glossy black, spotted with small pure green

scales, collected mostly on the spaces between the punctures; legs and antennæ dark violet; rostrum rather long, with a slightly elevated longitudinal line; prothorax manifestly longer than broad, considerably narrower in front, the sides rounded, roughly punctured above; scutellum small, triangular; elytra regularly but not strongly convex, with fine lines of punctures, the apices very slightly divergent; body beneath glossy black, the sides and base of the femora covered with bright green scales.

A very distinct species, resembling a slender *Otiorhynchus*.

*Eustales sejunctus*.

*E. oblongus*, late viridi-squamosus, supra lineis abbreviatis nigris denudatis notatus; rostro carina triangulari instructo; scutello rotundato. Long. 6 lin.

*Hab.* Brazil.

Oblong, partially covered with green scales, leaving on the upper surface oblong black glossy lines without scales; the head with three, the prothorax with five such lines, one on each side running through the eye and continuous with one on the prothorax; on the elytra the lines are uninterrupted and irregular; rostrum with a flattish carina, broader below and gradually running to a fine point between the eyes; prothorax subcylindrical, flattish above, with two large median impressions; scutellum roundish; elytra broadest behind the middle, depressed above, linearly punctate, the punctures much coarser at the base, posteriorly the fifth and seventh interstices raised, apices divaricate.

This and the following species are remarkable for the naked interrupted spaces on the upper surface. The club of the antennæ, as in many others of their allies, is black.

*Eustales interruptus*.

*E. angustus*, late viridi-squamosus, supra partim nigro-denudatus; rostro in medio triangulariter impresso; elytris apicem versus paulo ampliatis. Long. 4 lin.

*Hab.* Macas.

Narrowly oblong, partially covered with green scales, a few cobalt-blue, leaving on the upper surface oblong black patches without scales; rostrum with a triangular median impression, and on each side a short deep line; prothorax subcylindrical, longer than broad, two strongly marked depressions on the disk, and on the sides several coarse punctures; scutellum oblong; elytra rounded at the shoulders, depressed above, towards the apex slightly expanded, very



coarsely punctured, two rounded elevations posteriorly, apices divaricate.

A narrower species than the last; the naked black patches less definite, and absent on the head.

*Eustales impositus.*

*E. elongato-ovatus*, albo-squamosus, maculis irregularibus nitide nigro-fuscis denudatis variegatus; rostro carinato; elytris valde convexis. Long. 5 lin.

*Hab.* Chontales.

Elongate-ovate, varied above with more or less confluent patches of white scales on a glossy brownish-black naked derm; rostrum strongly carinate; prothorax slightly transverse, well rounded at the sides, subbisinuate at the base; scutellum triangular; elytra regularly convex, rounded at the sides, apices divergent, irregularly punctured, except towards the suture, punctures small, mostly filled in by the scales; body beneath with a naked brown longitudinal stripe; legs closely covered with small whitish scales.

An isolated species.

*Brachyomus metallescens.*

*B. elongato-ovatus*, squamulis cupreo-metallicis variis tectus; prothorace elongato, cylindrico; elytris postice bituberculatis. Long. 7 lin.

*Hab.* Sarayacu.

Elongate-ovate, covered with minute copper-coloured scales and a few scattered golden-green ones above and on the legs, golden-green scales more numerous beneath; rostrum slightly excavated in the middle, a short impressed line on each side; antennæ slender, dull purplish; prothorax much longer than broad, cylindrical, irregularly and somewhat transversely pitted above; scutellum small, rounded; elytra coarsely punctured, abruptly declivous behind, declivity marked by two large slightly compressed conical tubercles; legs rather slender.

This species differs from the *Brachyomi* generally in its cylindrical prothorax. I do not think that this is here sufficient to warrant generic separation. The genus is remarkable for being "exhumerate."

CLEOTEGES.

*Rostrum* modice elongatum, apice latius, supra angulare; *scrobæ* profundæ, arcuatæ, pone oculos desinentes. *Antennæ* articulis duobus primis funiculi subæqualibus. *Prothorax* margine postico

dilatato. *Elytra* prothorace multo latiora. *Femora* infra dentata. *Abdomen* segmento primo recto.

In all these characters this genus differs from *Compsus*, *Eustales*, and their allies. The anterior tibiæ are produced at the apex, but not into a naked mucro, as in *Compsus*; and in this respect it agrees with *Platyomus*.

*Clavoteges virosus.*

*C. ovatus*, squamis fuscis approximatis, aliis in maculis adspersis parvis viridibus, tectus; scutello majusculo, transverso. Long.  $5\frac{1}{2}$  lin.

*Hab.* Chontales.

Ovate, covered with approximate brownish scales, much darker on the back, and on which are a few small scattered pure green spots; the sides, legs, and under surface more or less obscurely blotched with pale brown and green; rostrum flattish above, the sides between the eye and the beginning of the scrobe bent down at an angle; antennæ with a rather short funicle, greenish, the club dark; prothorax narrow anteriorly, rounded at the sides, the basal portion suddenly expanded at the sides against the elytra, the disk coarsely granulate; scutellum rather large, transverse; elytra flattish above, raised on each side of the scutellum, transversely punctured, the interstices, except the third, scarcely raised, the third terminating abruptly at the deflexed portion in a short compressed gibbosity, below which is another, but smaller, on the fifth interstice, the apices mucronate at the suture.

## BIBLIOGRAPHICAL NOTICES.

*The Geological Antiquity of Insects.—Twelve Papers on Fossil Entomology.* By HERBERT GOSS, F.L.S. 8vo. London: Van Voorst, 1880.

THE subject of Fossil Entomology is certainly one which has not attracted many investigators. In this country scarcely any one hitherto seems to have devoted any continuous attention to fossil insects; and even on the continent the students of insect-remains are so few that the more important of them might almost be counted on the fingers of one hand. This is due, no doubt, to a considerable extent, to the fact that the occurrence of fossil insects is exceedingly sporadic: beds containing such objects occur only here and there; and when they turn up in quantity, the specimens obtained

generally fall into the hands of some one person who undertakes to work out the whole series. Mr. Goss, in his pamphlet now before us, suggests as another cause for the limited amount of interest shown in fossil insects, that very few geologists are capable of forming opinions upon even the general relationships of such fragments of insects as are usually met with in a fossil state. We should be inclined to go even a step further and say that there are very few entomologists, at all events in England, at all qualified by the breadth of their previous studies to undertake with profit this line of investigation.

Nevertheless, especially in view of the great addition to our knowledge of the insect-fauna of the past which recent researches in America seem to promise, it must be admitted that the study of fossil insects ought to be one of primary importance, particularly with regard to the question of the succession of organisms on the face of the earth. There can be little doubt that, if ever the theory of evolution is to be definitively established or disproved from the study of existing forms of animals, it is to the insects that we shall have to turn our special attention; and from this point of view the careful study of fossil insects and their comparison with those now living must also be of the highest importance.

Under these circumstances, we think that English entomologists and geologists have every reason to be grateful to Mr. Goss for having reprinted, in the form of a pamphlet, a series of twelve articles which he has lately contributed to the 'Entomologist's Monthly Magazine.' Without pretending to go very deeply into the subject, Mr. Goss has here given an excellent sketch of the constitution of the successive insect-faunas of the different geological formations, so far as they are at present known. For the purposes of the general palæontologist the information here carefully brought together by Mr. Goss will be of great value, and in many cases quite sufficient without any supplementary investigations; but for the service of those who may wish to carry their study of the subject, or any part of it, somewhat further, the author has carefully given references to the works from which his details are derived; and these, we believe, embrace, if not the whole, very nearly the whole of the published literature of fossil entomology. Future students will be much indebted to the industry of Mr. Goss for the valuable summary of this literature which he has thus produced.

*Journal of the Royal Microscopical Society.* Vol. ii. nos. 4 to 7 and 7 a, for June to December 1879. 8vo. Williams and Norgate, London.

THIS publication includes the Transactions and Proceedings of the Society, and a vast amount of information relative to Invertebrate and Cryptogamic organisms, and to Embryology, Histology, and Microscopy, as gathered from other publications at home and abroad. The enthusiastic Editor, Frank Crisp, LL.B. &c., has now associated with himself, in the work of translating, compiling,

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and editing, other accomplished and energetic Fellows of the Royal Microscopical Society, namely T. Jeffery Parker, B.Sc., A. W. Bennett, M.A., B.Sc., and F. Jeffrey Bell, B.A.; and the results of their combined work continue to be scientifically good and of great value to the Society to which they belong, and to the scientific world in general.

The original communications to the Society, upwards of forty in number, contain many excellent natural-history notes and memoirs, mostly illustrated, besides those in which the Microscope itself is the more important subject.

*Proceedings of the Yorkshire Geological and Polytechnic Society.*

New Series, vol. vii. part 2, pp. 107-218, with 7 plates. Edited by J. W. DAVIS, F.S.A., F.G.S., &c. 8vo. Leeds, 1879.

THIS latest publication of the long-established scientific Society of the West Riding of Yorkshire bears witness to its vitality and the intellectual activity of its Members. Mr. W. Morrison's address, short as it is, is strong in sensible remarks on the ill effects that "cramming" and prize-getting have on modern education, in which work is not done for the work's sake, but for some material end and self-aggrandizement. Local geology has many useful illustrations among the papers in this Part of the Proceedings, ranging from the coal-fields to the glacial phenomena of Yorkshire; and some of the papers, though treating of local facts, have philosophical bearings of wide application—such, for instance, as the Rev. E. M. Cole's paper on the origin and formation of the Wold Dales. For Natural History we find interesting and new matter detailed by Messrs. Cash and Hick in their communication on Fossil Fungi (pl. vi.) from the Coal-measures; and to the Cryptogams they refer Carruthers's *Traquairia*, also from the Halifax coal. Mr. J. W. Davis describes (without figures) some new Carboniferous fish-remains as *Ostracacanthus dilatatus*, which he thinks has strong Teleostean affinities. A summary of the geological literature relating to Yorkshire which has been published in 1877-78, the Minutes of Meetings (comprising a notice of Raygill Cave), the Report, and some miscellaneous matter complete this useful No. of the Proceedings.

## MISCELLANEOUS.

*On the Formation of the Shell in the Snails.*

By MM. LONGE and E. MER.

THE shell of the *Helices* consists of two principal layers, of organic and mineral nature, clothed with a cuticle which is wholly organic. The first of these layers is composed, commencing exteriorly, of a structure showing confused striation, of about the same thickness as the cuticle, and of another thicker one formed of vertical prisms.

It is to this that is due the general coloration of the shell, as also that of the spots and bands. The second layer, which is colourless and is commonly designated *nacre*, includes several strata of prisms arranged horizontally, and the axes of which, in two successive strata, are nearly perpendicular to each other. The cuticle and the calcareous layers are produced by different regions of the mantle, approaching nearer to the collar in proportion as the layers are more superficial. The cuticle is formed by an apparatus which we believe has not yet been described, and which we shall call the *cutogenic apparatus* (*appareil cutogène*). It is composed of two special organs situated immediately behind the collar. One of them consists of a furrow, to which we have given the name of the *pallial groove*, parallel to the margin of the mantle, and at the bottom of which glandular cæca open; the other, situated behind the former, appears, upon an antero-posterior section, like an epithelial wedge buried in the substance of the mantle. It is formed of long vertical cells, shaped like bottles, the orifices of which open at the base of the organ which we shall name provisionally the *epithelial organ*. These cells contain granules, which are isolable in potash, and a nucleus situated in their deeper-seated part. We must regard them as differentiated epithelial cells.

The cutogenic apparatus exists in the embryo when still enclosed in the ovular envelopes. At this epoch the shell is already furnished with a cuticle. It persists during the whole of the growth of the young snail, the epithelial organ showing itself under the appearance of a white border surrounding the margin of the mantle. In the adult it disappears and is replaced by the tissue of the mantle. The long-necked cells become converted into ordinary epithelial cells, capable of producing nacre. The pallial groove, on the other hand, always persists; but the glandular cæca which line its bottom are gradually atrophied. The consequence of this disappearance and atrophy is that a scar in the shell can no more be covered with cuticle in this region than in the other parts of the mantle, whilst this does take place when the animal is still in its period of growth.

According to our observations the function of the cutogenic organ is as follows:—The glands of the pallial groove secrete mucus, perhaps that substance which chemists have found associated with the calcareous matter of shells, and which they have named *conchioline*. The long-necked cells of the epithelial organ afterwards deposit the granules they contain in the membrane originating from the pallial groove. The cuticle is the result of this double secretion. What justifies our thinking that this is the case is, that when a young *Helix* increases its shell it may be seen to apply closely the margin of the mantle to the last-formed part in such a manner that the cutogenic apparatus borders this part. Above the groove a membrane destitute of lime soon makes its appearance. The animal is so adherent to the shell that it does not yield to those slight irritations which at other times would cause it immediately to withdraw.

We may sometimes succeed in killing it in this position, and then make antero-posterior sections embracing at once both the apparatus and the cuticle in course of formation. In some of these sections we have seen a streak of matter issue from the groove and become impregnated, above the epithelial organ, with granules escaping from the cells of the latter, the function of which would appear to be to consolidate the membrane secreted by the glandular cæca.

It is well known that the principal character of the adult *Helices* consists in the turning-out of the margin of the shell. According to the preceding statements, this eversion is explained as follows:—After the atrophy of the epithelial organ the portion of the mantle which it occupied sinks down, and in this depression carries with it the part of the cuticle which covered it. The anterior portion of this membrane situated above the pallial groove, the level of which has not changed, is thus raised, and is soon lined on its inner surface with the calcareous deposits which this region has acquired the power of secreting.

All the parts of the mantle posterior to those we have just been considering assist in the formation of the nacre. As regards the primitive forms under which the constituent elements of the various calcareous layers are deposited, we shall limit ourselves to the following remarks. If we examine a fragment of the delicate membrane detached from the margin of a shell in process of growth, we observe that the most recent part is formed almost exclusively by the cuticle; a little further back this is furnished with lines of spherical granules; further still these granules form a continuous calcareous layer lining the inner surface of the cuticle. In a young *Helix* from which a portion of the cutogenic apparatus has been removed, the outermost layer above the injured spot is formed in a different manner. We first of all see calcareous rods appear; and these gradually become enlarged at the two extremities, and acquire the form of small wallets (or saddle-bags). By the addition of fresh particles these wallets are converted into spheres, the dimensions of which are increased by concentric deposits with radiating striæ. These spheres finally come into contact with each other. The first calcareous stratum therefore is formed differently according as it is uncovered or protected by the cuticle. It is also in the guise of rods and spheres that the elements of the outermost layer are deposited in the cicatrical fragments consequent on denudations, both in the adult and in the young animal. This is the case also in the epiphragms, but with this difference, that granules poured forth by the calcareous glands of the collar are here mingled with the spheres with concentric layers. We have ascertained that the cicatrices of the shell are produced even when the part laid bare is covered immediately with a fragment corresponding to that which has been removed. Fine plates of mica introduced between the the shell and the mantle are lined on the inner surface with a calcareous deposit.—*Comptes Rendus*, April 12, 1880, p. 882.

*Metamorphoses of the Aphis of the Woody Galls of the Black Poplar*  
(*Pemphigus bursarius*, Linn.). By M. J. LICHTENSTEIN.

By indicating as synonymous with his *Aphis bursaria* the Aphides of which the galls are figured under the nos. 7-11 in pl. xxvi. of Réaumur's third volume, Linné has set his successors a problem to solve; for in this case the choice is embarrassing. Fig. 8 of the great French observer in fact presents, under the letters *h, g, u*, very different galls united on the same branch; and the entomologists who have copied Linné have taken sometimes one and sometimes the other species for *Aphis bursaria*.

Without wishing here to perform a work of criticism, I shall confine myself to saying that I regard as *Pemphigus bursarius* the insect of the gall figured by Réaumur under the letter *h*. It is the only gall that is fixed upon the bark; it is the only one that is of a hard woody consistency; further, it does not fall with the leaves; it is persistent, and may be very readily seen upon the poplars during the whole winter.

Up to the present time we have only known of the insect which forms this gall, the foundress-mother, and the emigrant winged progeny which quit the galls in June and July. No one has yet been able to discover where this emigrant form goes, nor have I been able to fill up this gap; but having placed in a tube these winged emigrant insects, I soon saw them deposit living young, all alike, and presenting a well-developed rostrum, a certain indication that they are destined to take food; only I have not yet been able to find what suited them, and they have all died in my bottles.

Now, in freedom, in the month of August, when the last *emigrants* had quitted the galls, I have seen arriving upon the poplars winged insects which, quite in opposition to the emigrants, seemed to endeavour to enter instead of issuing forth, and this, not only into the already dry galls, but into all the fissures of the bark.

The external appearance of these Aphides is almost the same as that of the emigrant form; I can find no difference between them except in the number and form of the crenulations of the third joint of the antennæ, which run all round the antennæ in the emigrant, and only pass half round in the new comers. But their product is quite different. Placed in tubes the new arrivals deposit what I call *pupæ* in the *Phylloxera*, and pupæ of two sizes, which very quickly free themselves from their envelope, and give origin to small sexual Aphides, male and female, destitute of the rostrum, and furnished with generative organs. Copulation takes place; and soon afterwards the female deposits, between the wrinkles or cracks of the old drying gall, a small yellow egg, surrounded by a white cottony down or secretion.

Is it not marvellous to see instinct thus carry back the *Pupifera* to the dwelling formed by their great grandmother, to bring back to it the young couples which are to furnish the single egg, the germ of the future colony?

Of this egg I have preserved numerous examples in my cabinet

through the whole winter ; for if each female furnishes only one egg there are an immense number of females. The egg hatched on the 11th May [March?]; and I placed the little *Aphis* which issued from it, and which is, of course, the larva of the foundress-form, upon a small poplar, which I planted on purpose in my garden. Now, on the 3rd April, I have the satisfaction of seeing my little artisans at work, burying themselves in the tender stalks of the first buds, and beginning to disappear beneath a little elevation which surrounds them like a halo, of a bright carmine tinge.

I had wished to be able to give the complete history of the biological cycle of this *Aphis* ; but I hope that what I have seen may facilitate the study of these interesting metamorphoses by other observers. However, the theories which I have already had the honour of presenting to the Academy with regard to *Phylloxera* and other species of Pemphigians are here again fully confirmed : there are four larval forms preceding the sexual forms ; and of these four forms two are apterous and two winged.—*Comptes Rendus*, April 5, 1880, p. 804.

### *Structure of the Eye of Limulus.*

By A. S. PACKARD, JUN.

The eyes of the horseshoe or king crab are four in number, consisting of a pair of compound eyes situated on the side of the head, and a pair of small simple eyes on the front of the head. As described by A. Milne-Edwards and Owen, the optic nerves to these eyes are very long and slender. Those distributed to the larger compound eyes are very long, and close to each eye subdivide into an irregular plexus of fine nerves, a branch being, as we have found, distributed to each facet composing the compound eye. The structure of the eye is very unlike that of any other Arthropod eye. The cornea is simply a smooth convex portion of the integument, which is much thinner than the adjoining part of the chitinous skin. There are no facets, the cornea externally being structureless, simply laminated like the rest of the integument. In the internal side of the cornea are a series of solid chitinous conical bodies, separated from one another by a slight interspace and in form resembling so many minié-rifle balls ; the conical ends of these solid cones project free into the interior of the body, and are enveloped in a dense layer of black pigment. Within the base of these cones are secondary, shallow, cup-like bodies or shallow secondary cones. It is these primary cones which, seen through the smooth, convex, translucent cornea, give the appearance of a faceted surface to the external eye.

All the parts thus far described, except the pigment layer, are moulted with the rest of the crust ; and the large, long, slender cones can be easily seen by viewing a piece of the cast-off eye, the solid cones being seen projecting from the inner surface of the cast-off cornea.

The internal structure of the eye is very simple. *There are no cones and no rods* ; but a branch of the optic nerve impinges directly



upon the end of the solid chitinous cone, as determined by removing the layer of pigment with dilute potash, and treating the section with acetic acid and then staining with picro-carmin. So far as we can ascertain, no Arthropod eye is so simple as that of *Limulus*. Our observations have been based on a study of the structure of the lobster's eye from preparations of very great beauty and delicacy, kindly made for us by Norman N. Mason, Esq., of Providence, who has also made beautiful sections of the *Limulus*-eye, after treating them in various ways. The question as to the nature of the solid cones we are not yet prepared to settle. Are they crystalline lenses or only analogous organs? Can the horseshoe crab distinguish objects? We doubt if its eyes enable it to more than distinguish between the light and darkness. Since the above remarks were put in type, we have seen Grenacher's great work on the eyes of Arthropoda. He regards the conical chitinous minié-ball-like bodies as corneal lenses. He does not describe the simple eye, which is a close repetition of one of the corneal lenses of the compound eye of the same animal, except that the lens is shorter and with the end much more obtuse.—*American Naturalist*, March 1880.

*Fossil Crawfish from the Tertiaries of Wyoming.*

By A. S. PACKARD, JUN.

Two specimens of fossil crawfish quite well preserved have been kindly lent us for description by Professor Leidy, who received them from the fish-beds of the western border of Wyoming, through Dr. J. Van A. Carter, of Evanston, Wyoming. Of the two specimens the smaller presents a dorsal, and the larger a lateral view, both being slightly distorted by pressure; the length of the smaller from the tip of the rostrum to the end of the telson is 38 millims., and of the larger 53 millims. They do not differ generically from existing species of *Cambarus*, though with some resemblances to *Astacus*; but as the gills are not represented it is not possible to say to which of these two genera the species belongs; still the weight of characters ally it nearest to *Cambarus affinis*, as seen in the long, narrow, pointed rostrum, and the form of the chelæ and the second antennal scales. These scales are also much as in *C. obesus*, var. *latimanus* and *Bartonii*, but rather narrower, the lateral terminal spine being long, slender, acute. The flagella of the second antennæ are of the usual size, extending to the terminal fourth of the abdomen. The distal end of the scape of the first antennæ reaches to near the end of the last joint of the scape of the first pair, the species in this respect being more like *Cambarus* than *Astacus*. The carapace is of the proportions of living species of *Cambarus*. The first pair of legs are rather shorter and stouter than in our living crawfishes, and the chelæ are rather shorter; while the surface of the carapace and legs is much more coarsely tuberculated than in our *Cambari*, and in this respect resembles large specimens of *Astacus fluviatilis* of Europe, though the tubercles are larger.

The abdomen is of the usual proportions, but the surface is more coarsely tubercled; the telson and broad rami of the last pair of feet are spined as in living species of *Cambarus*. It is interesting to observe that this species is most nearly related to *Cambarus affinis*, which, as observed to me by Mr. P. R. Uhler, who kindly gave me some species for comparison, is the more generalized American species of the genus, and probably the oldest one. It would be interesting to know whether this fossil form is actually a *Cambarus* or an *Astacus*, and to ascertain which of these two genera, now restricted, the latter to the Pacific slope of the Sierra Nevada, the former to the Central and Eastern zoogeographical provinces, was the first to obtain a foothold on our continent. There is a probability that the present fossil form is a member of the American genus *Cambarus*. The species may be called, therefore, *Cambarus primævus*.—*American Naturalist*, March 1880.

*On the Occurrence of Tachymenis vivax in Cyprus.*

By Dr. A. GÜNTHER, F.R.S.

Major-General R. Biddulph, C.B., has kindly placed in my hands a snake obtained on the Lapithos road in Cyprus, which proves to be *Tachymenis vivax*, a species not contained in the collection described by me in Proc. Zool. Soc. 1879, p. 741, and, indeed, as far as I can see, new to the fauna of the island. The captor, Capt. Stevenson, informed Gen. Biddulph that the natives call it "Kufi," and believe its bite to be fatal to man; the species, however, is entirely harmless, and evidently owes its bad reputation to its singular resemblance to a viperine snake, and more especially to the viper occurring in the island, *Vipera lebetina*. This is a case of so-called mimicry which would be very far from benefiting the species concerned.

The Cyprian specimen differs from all the other specimens in the British Museum (received from Xanthus, Syria, the Holy Land, and Dalmatia) in having twenty-one longitudinal series of scales, the typical form possessing nineteen only. It does not differ in other respects.

*On Dana's Lysiosquilla inornata.*

*To the Editors of the Annals and Magazine of Natural History.*

GENTLEMEN,—Allow me to state that I think Mr. E. J. Miers is perfectly right in referring (Ann. & Mag. Nat. Hist. ser. 5, vol. v. p. 8) the *Squilla* from La Guayra to Dana's *Lysiosquilla inornata*. When I wrote my letter, published in P. Z. S. 1870, I had no access to Dana's work; but I was afterwards able to compare his description with the specimen in our Museo Nacional; so that another one was given by me, in December 1877, under that name to Mr. William Stürup, Danish Consul-General in this city, who, I believe, sent it to the Museum in Copenhagen.

I am, yours very truly,

Carácas, March 18, 1880.

A. ERNST.

# THE ANNALS

AND

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XL.—*Report on Specimens dredged up from the Gulf of Manaar and presented to the Liverpool Free Museum by Capt. W. H. Cawne Warren.* By H. J. CARTER, F.R.S. &c.

[Plates XVIII. & XIX.]

THE Gulf of Manaar is an inlet of the Indian Ocean, between Ceylon and the southern extremity of India, 150 miles in width at its entrance; and the specimens, which were dredged up by Capt. W. H. Cawne Warren, in 65 fathoms and less, off the town of Negombo, near Colombo, on the coast of Ceylon, and Tuticorin on the coast of India respectively, towards the end of 1878, were presented to the Liverpool Free Museum about a year afterwards, when they were sent to me for examination by Mr. Thomas H. Higgin, F.L.S.

As they all possess a similar facies, it will only be necessary to allude to them hereafter as “from the Gulf of Manaar,” without specifying the particular locality more than has already been done.

Altogether they would hardly fill a quart measure; and the largest was not more than three inches in its longest diameter; so that the amount of material is insignificant. But the representatives of species are comparatively enormous, as will be seen hereafter; indeed, if this material is to be taken as typical of what is to be found in the Gulf of Manaar generally, I should think that this little inlet must contain an epitome of

nearly all the marine organisms that exist in the Indian Ocean.

The "specimens" consist of calcareous nodules of different sizes, which may be said to originate, in the first place, in the agglutination of a little sea-bottom by some organism into a transportable mass, which, increasing after the same manner as it is currented about, may finally attain almost unlimited dimensions. They are therefore compounded of all sorts of invertebrate animals, whose embryos, swimming about in every direction, find them, although still free and detached, of sufficient weight and solidity to offer a convenient position for development; and hence the number of species in and about them.

They vary in form and weight in proportion to the amount of loose or solid material in them, some being round, hollow, clathrous, others more solid, but much creviced, and some almost entirely solid; while they may be more or less rugged on the surface from the nature of the organisms of which they are chiefly composed, whether through development *in situ* or subsequent agglutination. Perhaps no family of organisms has entered into their composition or increased their solidity more than the calcareous Algæ (*Melobesia*), which, in successively laminated or nulliporoid growths, has rendered these nodules almost solid throughout or covered with short, thick, nulliporiform processes. I am not sufficiently acquainted with the calcareous Algæ to say what the species are; but the common incrusting one hardly differs from our *Melobesia polymorpha*; and this seems also to have produced the nulliporoid growths to which I have alluded. There is also another laminar species with larger cells which are quadrangular; but this does not appear to be so common, while the loose, deciduous, flat, reniform articulations of *Flabellaria opuntia* are agglomerated with every thing, showing that this calcareous alga or coralline, which is very common in the tropics generally, is not less so in the Gulf of Manaar.

As it is upon these agglutinated compounds, as well as in their crevices and the excavated cavities formed by lithodermous sponges in them, that the organisms to be hereafter mentioned have been developed, I shall henceforth allude to the former under the term of "Melobesian nodules."

Next to the part which the *Melobesia* have taken in their formation may be mentioned the sessile Foraminifera; and these have, in their turn, been overgrown, in many instances, by Polyzoa, which, too, is a class of which I know so little that I am not able to point out the different species present;

but observing them to be abundant and as beautiful as they are varied in form, while many are evidently not British, I have placed such of them as, in breaking up the nodules for other organisms, were necessarily separated, in a box by themselves, for some one who, desirous of describing the exotic species, may one day be permitted to examine them for this purpose.

For my own part, the Foraminifera and Spongida are as much as I can pretend to undertake; and these, together with a new genus of the Hydractiniidæ and a new species of *Tubipora*, will be found described and illustrated in the following pages.

But although the forms of the Foraminifera that I have mentioned are fully developed, and therefore admit of complete description and illustration, those of the Spongida in several instances are not so. Then it should be remembered that the form of a fully developed sponge is frequently by no means constant, while every fragment of it is almost sure to contain its whole spiculation; and this alone is what is found in many cases on the Melobesian nodules. Hence, the name of a sponge being for the most part derived from the form of its spicules, this enables us to supply it, together with a description of the latter, which is all that is required until a fully developed form is found.

Before commencing these descriptions, however, I would observe that the mountings that I have made of some of the dust that fell off the root-branch of *Euplectella cucumer* (now in the British Museum) which was hooked up by a fisherman in deep water off the Seychelle Islands afford a complete index to the Manaar specimens, with many other forms besides, which may yet exist in the neighbourhood; but I have not met with any traces of gold among the sand obtained from some of the nodules, although the blue sapphire which is found in Ceylon is as evident in them as in the sea-bottom from the Seychelles ('Annals,' 1878, vol. i. p. 102).

Another fact I would also here mention, viz. that throughout my examinations, which have chiefly been conducted under the microscope, and often with high powers, I have never observed a *Coccolith*, *Coccosphere*, or *Rhabdolith*.

The descriptions and illustrations respectively of the new genus of Hydractiniidæ and new species of Tubiporidæ will be found in this part of my communication for convenience of publication &c., rather than on account of proper sequence; this will be corrected in the terminal list of the "Report."

## FORAMINIFERA.

*Sessile Species.*

## Genus CARPENTERIA, Gray.

*Generic characters.* Test conical, sessile ; composed of elongated more or less triangular chambers developed successively in a spire, more or less regularly round a hollow axis, towards which they are inclined and into which they open. Chambers foraminated on the surface, and more or less filled in the interior with fragmentary sponge-spicules. Hollow axis prolonged from the summit into a branched fruticose head.

*Carpenteria utricularis* and *Carpenteria monticularis*.

The former abounds on the Melobesian nodules of the Gulf of Manaar ; but of the latter I have only found one specimen.

In 1876 (Ann. vol. xvii. p. 210, pl. xiii. figs. 11-16), I described and illustrated *C. utricularis* under the name of *Polytrema utricularæ*, and in 1877 (Ann. vol. xix. p. 211) reverted to the old generic appellation, viz. *Carpenteria*, adding at the same time (*ibid.* pl. xiii. figs. 9-12) a new species, viz. *C. monticularis*; while in 1878 ('Palæontographica,' [3] xxv. 1, Taf. xl. figs. 58-61) Prof. Möbius figured the same *en masse*, under the name of *Carpenteria raphidodendron*.

## Genus POLYTREMA.

*Gen. char.* Test massive, more or less divided at the summit, composed of cells or chambers developed laminarly upon each other, the outer ones foraminated on the surface and opening into the inner ones, whose cavities, communicating with each other, finally terminate at the ends of the branches or laminæ into which the summit may be divided, where they are more or less filled with fragmentary sponge-spicules.

*Polytrema miniaceum*, De Blainville.

This species, which abounds everywhere in the tropics (but is rare, perhaps, beyond the 35th parallel on each side of the equator), varying in colour from deep red to pink, cinnamon, and pure white, is in its pink colour equally abundant in the Gulf of Manaar, growing apparently indiscriminately on every organism that will bear its weight. Accompanying it is another species, which, although not so frequent, being new I shall designate as *P. cylindricum*, in reference to its form, as will be seen hereafter. Finally, there is a third organism on the

Melobesian nodules, which, being polytrematous (literally), possessing fragmentary sponge-spicules in its interior, and presenting the same red colour as *P. miniaceum*, I at first thought to be another new species; but on further examination it was found to be a reptant *Tubipora* so like *T. musica* that, but for its stoloniferous growth and consequent modifications, together with the presence of the fragmentary sponge-spicules incorporated with its corallum, it might be considered identical. This species I shall designate *Tubipora reptans*; and, although belonging to the Polypifera, it will be described here for convenience, as before noticed, on account of the great resemblance to *Polytrema* just mentioned.

Here also I would take the opportunity of introducing another species of *Polytrema*, which accidentally came into my possession, in a rolled state, having probably been picked up upon some beach; but where, I am ignorant. Imperfect as it is, however, it is remarkable for its size and other characteristics: with a *Polytrema*-like structure and pink colour, it is so much larger and so differently formed from any hitherto published, that it must be considered a new species, which I propose to designate (also in reference to its form) *P. mesentericum*.

These species will now be respectively described, beginning with

*Polytrema cylindricum*, n. sp. (Pl. XVIII. fig. 1, a-g.)

Erect, cylindrical, consisting of a thick round pillar developed from a slightly expanded base, dichotomously divided at the free end into two short thick branches, which are equal in length and opposite, terminating respectively in an expansion, from the centre of which radiate a number of more or less fragmentary sponge-spicules. Consistence stony. Colour red, cinnamon, or crimson; translucent (Pl. XVIII. fig. 1). Surface of the pillar and branches uniformly divided into gentle convexities, pierced with foramina which are sunk into a sub-reticulated lineation whose interstices vary in prominence with the development of the organism—being most prominent in the oldest parts, and *vice versâ* (fig. 1, e); ends of the branches rendered irregular by the outgrowth of cells, which are otherwise hidden in the pillar and branches, as will appear presently. Cells at the ends of the branches bearing respectively a large aperture, similar in form, position, and margination to that of the cells of *Planorbulina* (fig. 1, c), which they further resemble in the form of their pore-tubulation; divided into two groups by a central rima, presenting a number of apertures, out of which project the fragmentary sponge-spicules

before mentioned, some of which may be seen in the large apertures as well as cavities respectively of the terminal cells themselves (fig. 1, *d*). Internal structure consisting of cells or chambers of different sizes, the largest and most regularly formed of which are arranged cortically (fig. 1, *a*), where their outer wall, corresponding to the "gentle convexities" on the surface, is pierced by the pore-tubules (fig. 1, *f*, *g g*), whose sunken apertures there are the holes also before mentioned (fig. 1, *e*); opening internally into a cancellated axial structure (fig. 1, *a*), whose cavities, communicating freely with each other, finally terminate in the rima between the groups of free cells at the ends of the branches respectively. Cells generally more or less filled with fragmentary sponge-spicules, especially the free ones at the ends of the branches (fig. 1, *b*). Size of specimens (which are very constant in this as well as in their form) about 1-3rd inch long and 1-12th inch thick; branches 1-16th inch long and a little less in diameter than the pillar.

*Hab.* Marine, growing on hard objects.

*Loc.* Gulf of Manaar.

*Obs.* This is undoubtedly a species of *Polytrema*, as evidenced by its structure, colour, and the presence of fragmentary sponge-spicules at the ends of the branches, in the interior of the cells, and on their way to them respectively through the apertures mentioned. Its size and form appear to be very constant, as above stated, although in one instance there was a tendency to divide in one of the groups of cells at the ends of the branches. What the object of taking in alone so many "fragmentary sponge-spicules" can be with these Foraminifera, when there are so few comparatively incorporated with the substance of the test, I am unable to conceive, especially as the very fact of their being "fragmentary" shows that they must have been drifting objects unaccompanied by any sponge-sarcode for nourishment, since "fragmentary spicules" do not, as a rule, exist in a living sponge.

*Tubipora reptans*, n. sp. (Pl. XVIII. fig. 2, *a-k*.)

Corallum strong, stoloniferous, vermiculate or crooked, not branched, flat, following the form of the surface on which it may be growing, bearing short, erect, cylindrical calyces situated at unequal distances from each other. Colour crimson, translucent (Pl. XVIII. fig. 2). Surface uniformly rough and foraminated, from the holes being sunk in the substance of the coral and the intervals in relief (fig. 2, *h*). Calycle sur-



mounted by an octotentaculated head (fig. 2, *a*), which is almost colourless, especially towards the centre, and from its more tender nature now, in the dried state, sunk into the calycle, while the firmer wall of the latter thus gives it the appearance of having been truncated. Tentacles composed towards the extremities of small, cylindrical, curved and colourless spicules (fig. 2, *f*), becoming larger, longer, and tuberculated towards the base (fig. 2, *g*), where they begin to assume a pink colour, and finally becoming red their tubercles unite with those of the neighbouring spicules, and thus the whole is transformed into the foraminated, fully formed, red, continuous corallum. Calycle charged at the bottom with fragmentary sponge-spicules, which are more or less incorporated with the red substance of the corallum there, and projecting upwards present, when the soft parts above them are removed, an echinated appearance, in which the ends of the spicules are simply branched or otherwise terminated in accordance with their forms respectively (fig. 2, *k*). Stolon compressed vertically (fig. 2, *b*); its wall in structure the same as that of the calycle; its cavity compressed in like manner, so as to be reduced to a minimum, like that in the horizontal plate of *T. musica* (fig. 2, *c*).

Size of specimen described about 6-12ths inch long, upon which there are eight calycles at variable distances from each other below 1-10th inch. Stolon, of which the growing ends are broken off up to the part where their spicules have become consolidated into the fully formed structure of the corallum, about 1-50th inch broad and 1-130th inch high, including the walls above and below, which reduces the vertical thickness of the cavity to 1-450th inch. Calycle about 1-36th inch high and 1-30th inch broad, including the walls; a little larger above than below.

*Hab.* Marine, on hard bodies.

*Loc.* Gulf of Manaar.

*Obs.* As before stated, the striking resemblance of this corallum to the test of *Polytrema miniaceum* in composition, structure, and colour, together with the presence of fragmentary sponge-spicules more or less incorporated with the corallum, led me to regard it at first as a species of this Foraminifer; but subsequent microscopical examination showed that it was almost identical with *Tubipora musica*, as the above description proves. However, I prefer its insertion here, and alluding to this hereafter by name in its proper place, for the purpose of pointing out its several characters in common with *Polytrema*, which otherwise might pass unnoticed.

*Polytrema mesentericum*, n. sp. (Pl. XVIII. fig. 3, *a-h*.)

(Rolled specimen.) Test massive, composed of more or less erect, thick, meandering laminae united mesenterically. Consistence stony. Colour pinkish red (Pl. XVIII. fig. 3, *3 a*). Surface (*i.e.* vertical sides of lamina) uniformly dimpled and foraminated (fig. *3b, h*); margin worn away by attrition (fig. *3, c*). Internal structure of lamina consisting of cells or chambers of different sizes, the largest and most regularly formed of which are arranged cortically, where their outer wall is pierced by the pore-tubulation, whose apertures on the surface are the foramina before mentioned (fig. *3, c, d, e e*); opening internally into a cancellated axial structure, whose cavities, communicating freely with each other, finally open at the margin in a corresponding position with respect to the cortical chambers (fig. *3, d, g*); thus presenting a more compact structure between the layers of the latter, which, in the absence of the real margin now worn away, presents the appearance of a stony polyzoarium of a similar form. Fragments of sponge-spicules incorporated here and there with the substance of the test (fig. *3, d, i*). Size of specimen, which is now rounded by attrition, subelliptical and compressed vertically, 3-4th inch by 7-12th inch in its greatest horizontal diameters, and about 1-4th inch thick; lamina 1-16th inch in transverse diameter.

*Hab.* Marine.

*Loc.*?

*Obs.* Although none of the exposed chambers at present contains any sponge-spicules (probably from their having been washed out), and the structure of the margin is worn away, yet by the presence of fragments of sponge-spicules incorporated with the substance of the test, and the character of the structure of the lamina internally, there can be very little doubt that when in a perfect condition it closely resembled *Polytrema cylindricum* in these respects. Still its peculiar form and size not only claim for it a separate designation, but the latter precedence also of all other species of *Polytrema* that have been publicly noticed. Comparing its form with that of the figure of *Theone*, Lamouroux (Jurassic fossil from Caen), given by De Blainville, Man. d'Actinol. Atlas, pl. lxvii. fig. 2, one cannot help being struck with their great resemblance. In many respects also it closely resembles the mesenteric forms of several exotic Polyzoaria.

#### Genus GYPSINA.

*Gen. char.* Massive, sessile or free, incrusting indefinitely or circumscribed and defined; surface uniformly tessellated

by foraminated interstices variable in form and separated from each other by reticulated lines of translucent shell-substance, which is frequently very prominent and transparent at the angles, forming the ends of a columnar structure in which the cells are united laterally by holes of intercommunication, and above and below by a foraminated plate, like that of the "interstice" on the surface, through which the innermost cell thus indirectly obtains communication with the exterior. No oral aperture. No canal-system.

Such are the characters of this genus, which is founded on the species, *Gypsina melobesioides*, that I described in 1877 ('Annals,' vol. xx. p. 172); but as the facts leading to it were communicated at intervals, and are now confirmed by specimens of each of the species contained in the genus, from the Gulf of Manaar, I will briefly recapitulate what has been stated.

When I showed, in March 1877 ('Annals,' vol. xix. p. 215 *et seq.*), that *Tinoporus vesicularis*, Carpenter (Introduction, p. 224, pl. xv. figs. 1-3), had "no generic affinity with De Montfort's *T. baculatus*," I was not aware of the existence of the incrusting species to which I gave the name of *Gypsina melobesioides* (*op. et loc. cit.*); but seeing that the structure of the latter was identical with that of Dr. Carpenter's *Tinoporus vesicularis*, I at once realized the necessity of changing the generic name of the latter also to *Gypsina*, thus making it *G. vesicularis*, Carpenter (*ibid.*). Had Dr. Carpenter, instead of applying De Montfort's name of *Tinoporus* (*T. baculatus* being a *Calcarina*), given it a new name, then this might have been used instead of the one I have proposed.

Further, I observe that the Foraminifer to which I gave the name of "*Polytremaplanum*" ('Annals,' 1876, vol. xvii. p. 211, pl. xiii. figs. 18, 19), and which came from the south-west coast of Australia, was a specimen of *Gypsina melobesioides*; hence its name also will have to be suppressed, at the same time that another locality is thus added to those already noticed of *G. melobesioides*, viz. the Mauritius, the West Indies, and, lastly, the Gulf of Manaar.

*Gypsina melobesioides*, sp. 1877.

There are four specimens of this species among the dredgings from the Gulf of Manaar, two of which nearly cover globular nodules of *Melobesia*, respectively half an inch in diameter, with an incrustation about 1-48th inch thick and twelve cells deep. The other two are also on the surface of similar nodules, but not so extensive. The incrustation spreads itself continuously over whatever irregularities may

be in its way, so as to give the whole the appearance of being frosted with sugar like a bridecake; hence it is very likely, without the aid of a microscope, to be confounded with *Melobesia* as well as the white incrustation of some *Gorgonias*.

*Gypsina vesicularis*, Carpenter.

Several specimens of this species also occur, in the sessile and free forms respectively. The sessile is hemispheroidal and for the most part the largest, while the free one is spheroidal and much smaller. Frequently the hemispheroidal form is sunk into the flat surface of a Coralline, subtridentate articulation (*Flabellaria opuntia*), where it is covered by a thick sarcodic cuticle; and in this state I have specimens also from the Straits of Carimata, on the west coast of Borneo; while the spheroidal variety, being free, may be found anywhere. The former is well described and illustrated by Dr. Carpenter (Introduction, p. 225 &c., pl. xv. figs. 1-3); and I have illustrated the structure of the latter ('Annals,' 1877, vol. xix. pl. xviii. figs. 18-20).

TESTAMŒBIFORMIA, new group.

*Char.* Amœbiform, testaceous.

Hitherto almost exclusive attention has been given to the *free* Foraminifera, whose exquisitely varied forms, although in many instances microscopic, have not unnaturally proved as attractive as the frustules of the Diatomaceæ; so that it has become an object of great search among them to find out a new form, although it can hardly be seen by the unassisted eye. This to the specialist is a matter of paramount importance, but to the biologist one of insignificance compared with the less attractive and larger forms, which tend to reveal the life-history and connexions of the class generally.

For some time past I have anticipated the existence of amœbiform Foraminifera, differentiated only by the peculiarity of their respective pseudopodial expansions; but, of course, this cannot be ascertained except by minute and laborious examination of the *living* so-called "*Bathybius*," which probably abounds with them after the manner of freshwater rhizopods, forming a similar slime to that which may often be observed over the bottom of stagnant (*i. e.* still) freshwater pools. I was not, however, prepared to find that some of these ever-changing forms were stereotyped, as it were, by the permanent secretion of a calcareous test, until the *Melobesian* nodules from the Gulf of Manaar came under my notice, when I observed two well-characterized forms to be very abundant in

them, which I will now describe under the generic names *Holocladina* and *Cysteodictyina* respectively, having already above defined the general characters of the group under the term *Testamœbiformia*.

*Holocladina pustulifera*, n. sp.  
(Pl. XVIII. fig. 4, a-g.)

Test radicleform, polychotomous, free towards the centre, fixed by the terminations of the rootlets at the circumference. Consistence hard. Composition calcareous. Colour white (Pl. XVIII. fig. 4). Surface even, pustuliferous, pustuliform eminences of different sizes scattered over the surface irregularly (fig. 4, e), plentifully about the centre, sparsely on the branchlets, in the form of smooth, hemispherical projections, varying in diameter under 1-600th inch, terminating in a slight papillary eminence with a punctum in the centre (fig. 4, b, c), sometimes extended into a short conical spine (fig. 4, d); ends of the rootlets subpalmate, terminating in amorphous granular projections (fig. 4, h), alternating with conical processes, which appear to be perforated at the extremity respectively; and if so, here would be the oral apertures (fig. 4, g g). Surface of the test between the pustuliform eminences bearing the appearance of being so minutely micropunctate as to be hardly distinguishable under a high power. Internally, structure of the test-wall, which varies in thickness under 1-50th inch, composed of extremely minute tubules in juxtaposition, perpendicularly descending from the surface to the interior (fig. 4, f), which in its dried state is now hollow and without foreign material, but still presenting the remains of the sarcode in the form of a thin yellow layer adherent to the inner surface of the test. Size of most perfect specimen about a quarter of an inch in its longest diameter.

*Hab.* Marine, in the crevices of Melobesian nodules.

*Loc.* Gulf of Manaar.

*Obs.* It is evident from the form of this test that the living animal possessed an amœboid form; but whether both were developed successively (that is, one part after another like the crust on a stream of lava), or the living animal was fully developed before the test was secreted, there is no evidence now to show, beyond the presumption that the former was most likely the case. The absence of all foreign material in the interior, together with its form, distinctly separates it from the genera *Carpenteria* and *Polytrema*, while it chiefly differs from *Aphrosina* (Journ. Roy. Microscop. Soc. 1879, vol. ii. p. 500, pl. xvii. figs. 5-10) in not being multilocular. No oral apertures were satisfactorily seen; but it may fairly be

inferred, as above stated, that each of the conical projections on the terminal branchlets bears one, through which a pseudopodium issues during the living state, in search of that subtle kind of nourishment which the present emptiness of the test indicates to have been the nature of the aliment.

*Cysteodictyina compressa*, n. sp.  
(Pl. XVIII. fig. 5, *a-e*.)

Test bladder-like, flat, compressed, interrupted in its continuity by holes of different shapes and sizes, which thus give it a reticulated appearance (Pl. XVIII. fig. 5); spreading flatly over the surface of hard bodies, and thus following their irregularities. Consistence firm, but fragile from its thinness. Composition calcareous. Colour white, yellowish, or lilac. Surface even, uniformly punctate; puncta distinct, in juxtaposition; circumference terminating in short radiform expansions like those of *Holocladina*, viz. in conical points (fig. 5, *dd*), mixed with an amorphous structure here and there like calcareous sand-grains (fig. 5, *ee*). Internally, test almost too thin for measurement, traversed vertically by tubules in juxtaposition extending inwards from the surface, terminating on the inner side in the midst of their prismatic divisions respectively (fig. 5, *b*). Cavity of the test without foreign material, continuous, and presenting the same kind of dried sarcodic lining as that of *Holocladina*. Size of most perfect specimen about half an inch in its longest diameter, by about a quarter of an inch wide and about 1-160th inch thick. Wall, as before stated, almost too thin for measurement.

*Hab.* Marine, on the surface of hard bodies and in their crevices.

*Loc.* Gulf of Manaar.

*Obs.* This species differs from *Holocladina* in not being branched, but membraniform and lobate, in the greater thinness of the test-wall, the absence of pustuliform eminences on the surface, and the larger size of the pore-tubulation. In other respects the same observations apply to it as to *Holocladina*. The amorphous sand-like development here and there on the processes of the circumference reminds one of the amorphous structure at the ends of some tendrils in the vegetable kingdom, and may serve a similar purpose.

CERATESTINA, n. gen.

*Gen. char.* Test horny; colour dark amber, translucent.

The composition of the test here brings us one degree nearer than that of the *Testamœbiformia* to the absolutely

naked Foraminifer, to whose conjectured existence I have before alluded; but lest it might be thought that it is merely the chitine without the calcareous material which characterizes this genus, it should be mentioned that, if a specimen of *Ceratestina* and an ordinary calcareous test of a Foraminifer together be exposed to the influence of an acid solution (*ex. gr.* dilute nitric acid), the latter will be dissolved and leave scarcely any residue, while the former remains unaffected, proving that the horny substance of the *Ceratestina* is something more than the chitine which may support the calcareous material; indeed the best way of extricating a *Ceratestina* is to put the calcareous substance containing the specimen into a strong solution of nitric acid, which, all know, is instant destruction to a calcareous test. This kind of Foraminifer, besides occurring in the cavities excavated by lithodermous sponges in the Melobesian nodules of the Gulf of Manaar, is often observed on the *surface* of old coral. In some cases the foraminiferal test is composed in one part of the ordinary calcareous material, and in the other of the horny substance only, which condition is so usually seen in one species that it would appear to be rather natural than accidental. I allude to a species which I have figured and described, conjecturally, as the "embryonic form" of *Carpenteria monticularis* ('Annals,' 1877, vol. xix. p. 213, pl. xiii. fig. 11), but which now, finding it to be a distinct species, I would name "*Carpenteria microscopica*." The chambers of *Carpenteria utricularis* and also the cells of *Polytrema miniacum* are often lined by a stiff horny layer of considerable thickness; but under what circumstances, I am ignorant, as it does not occur always; this, however, is secondary and must not be confounded with *Ceratestina*, in which the horny structure is primary and permanent.

*Ceratestina globularis*, n. sp.

(Pl. XIX. fig. 6, a-g.)

Test composed of four or more subglobular chambers developed one after another from a primary or embryonic cell, which is subspheroidal and presents the first bud of the stolonian siphon. Composition horny. Colour dark amber (Pl. XIX. fig. 6). Chambers increasing in size as they are successively developed upon the stolonian siphon (fig. 6, c) proceeding from the embryonic cell, which is the smallest (fig. 6, a); arranged more or less spirally, fitting upon each other, as they are successively developed, by the convex surface of the preceding being received into a lunate one of the following chamber (fig. 6, c), and all tied together on the inner side of

the spire by the stolonie siphon mentioned (fig. 6, c). Surface of the chamber smooth, indistinctly microspinose and micropunctate (fig. 6, e). Size of the group about 1-36th inch in diameter.

*Hab.* Marine, in minute cavities of the Melobesian nodules, which have been excavated by lithodomous sponges.

*Loc.* Gulf of Manaar.

*Obs.* Besides the specimens which come from the cavities above mentioned in the Melobesian nodules, I possess pieces of old *Stylaster sanguineus* from the South Pacific Ocean bearing several specimens on the surface (fig. 6, f). Like the last chamber in the figured specimen from the Gulf of Manaar, which has put forth two stolonie knotted tubular filaments and was in the act of putting forth more (fig. 6, d d), some of those on the surface of the *Stylaster* coral are connected with a similar filament. How far the chambers of those from the Gulf of Manaar were originally arranged together in juxtaposition and spirally I am not able to state, further than that their forms indicate it, since to see them satisfactorily it was necessary to dissolve them out of the Melobesian substance with acid and mount them in Canada balsam, during which the chambers became separated.

*Ceratestina tessellata*, n. sp.  
(Pl. XIX. fig. 7, a-h.)

Test lobular, adenoid, connected with a crooked, knotted, stolonie filamentous tube. Consistence horny. Colour dark amber (Pl. XIX. fig. 7, a, b). Developed upon a stolonie tubular filament in a globular form (fig. 7, c), which, becoming multiplied as the mass increases in size, passes into a lobulated group whose walls are traversed by straight unbranched lines of fibre intersecting each other at various angles, and thus giving the surface a meridionate or tessellated appearance (fig. 7, d), not rising above the level of the outer surface, but sending inwards processes which in the living state may have supported delicate partitions, and thus have rendered the interior multilocular (fig. 7, f). External surface of the wall smooth, with the exception of microscopic points which are sparsely scattered over it (fig. 7, h). Stolonie tubular filaments, which are often knotted (that is, bearing several successive dilatations and here and there conical processes indicative of budding development), hollow, and characterized throughout by the tessellated fibrous structure above described, only in a less visible degree (fig. 7, g). Size of largest group or specimen 1-25th by 1-45th inch in its greatest dimensions.



*Hab.* Marine, in cavities of the Melobesian nodules, which have been excavated by lithodomous sponges.

*Loc.* Gulf of Manaar.

*Obs.* In composition, colour, and position, together with the micropointed surface and its connexion with the crooked, knotted, filamentous, stolonie tubulation, this organism resembles *Ceratestina globularis* more than any thing else that I know of; but there is no visible appearance of punctures in the wall. The knotted form of the stolonie tubulation reminds one of the successive moniliform chambers in the so-called Placopsiline Lituolida—equally so in form, although not in consistence, of the creeping tubulation of the Saprolegnieæ and Myxomycetic fungi, to which in nature the Foraminifera very nearly approach. In consistence, however, they are more like the penetrating developments of the kerataceous sponges, but in structure totally different; for the fibre in the latter is not only infinitely branched, but, in all instances that I am aware of, cactiform—that is, puckered up into little monticules on the surface, which is thus rendered most uneven.

One cannot help here associating the amber colour of *Ceratestina* with the bright brown, or red cinnamon colour of most of the Lituolida, which appears to be thus modified by admixture of the chitine in the latter with the white mineral substance of which the test is otherwise composed.

### *Subsessile Species of Foraminifera.*

#### Genus *ROTALIA*, D'Orbigny.

The genus *Rotalia*, sometimes parasitic, but, according to Williamson, "usually free," is under the former condition characterized by being flat on one side, by which it adheres to the object on which it may be fixed, and convex on the other; but although many of the latter may be easily detached without injury, still there is one in particular, viz. *Rotalia spiculotesta* ('Annals,' 1877, vol. xx. p. 470, pl. xvi. figs. 1-3), which is so thin and delicate, and so firmly fixed to the object on which it may be growing, that it may be fairly inferred that it remains in this position for the whole period of its existence. As I have found several specimens of this species on the Melobesian nodules of the Gulf of Manaar, and hitherto have only had one to describe from, viz. that to which I have alluded (*op. et loc. cit.*), although Mr. H. B. Brady has obtained three from the Red Sea, whereby he has been able to ascertain that the composition of the spiculiform bodies in the test is calcareous, still it is desirable that I should state, by way of confirmation, what

the Manaar specimens have revealed respecting this beautiful little organism.

*Rotalia spiculotesta*, sp. 1877.

To the description of this species given in the 'Annals' of 1877 (*l. c.*), and the intimation of Mr. H. B. Brady that he had obtained three specimens out of "dredgings" from the Red Sea, whereby he had been able to ascertain that the spiculiform bodies of the test were calcareous, I have little to add. In the first place, then, it is evident that the number of specimens about the small amount of material from the Gulf of Manaar indicates that it is very plentiful there; they (six) are all about the same size as that which I originally described; and if any difference exists between the two, it is simply that the spiculiform bodies in the Gulf-of-Manaar specimens are more quadrangular or oblong than elliptical, while they are the reverse in that to which I have alluded, viz. that which came from the South Pacific Ocean; they are respectively fixed upon the surface of the Melobesian nodules; and, with so much material, I have been able to mount a fragment of the test in Canada balsam for examination of the spicules under a higher power, whereupon they seem to me to be solid and the granular matter between them to consist of microscopic bodies of the same form, although of different sizes. I have also been able to confirm Mr. Brady's observation that they are calcareous, inasmuch as they dissolve entirely, with effervescence, in dilute nitric acid.

Although all the specimens to which I have alluded appear to contain nothing but the spiculiform bodies in their tests, I have met with some smaller (? young) specimens of the same Foraminifer about the Melobesian nodules, which, when mounted in balsam, show that their tests are at this period composed of a heterogeneous assemblage of microscopic bodies (? calcareous sand), in the midst of which one or more of the genuine spicular ones form prominent features, from their large size and isolated condition. Thus it may be that sometimes the test is composed of foreign material as well as bodies produced by the animal itself—a condition among the testaceous freshwater Rhizopoda to which Dr. G. C. Wallich has alluded in his valuable paper "on Structural Variation among the Diffugian Rhizopods" ('Annals,' 1864, vol. xiii. p. 233 &c.).

*Free Species of Foraminifera.*

As it is not my object to give a list of all the free forms of Foraminifera that occur about the Melobesian nodules, it will

be restricted to those only whose size renders them most conspicuous, none of which sensibly exceed an eighth of an inch in diameter; and these belong to D'Orbigny's genus *Amphistegina*, for a more intimate acquaintance with which I must refer the reader to Profs. Parker and Jones's account (*apud* Carpenter, 'Introduction,' p. 242).

#### AMPHISTEGINA, D'Orbigny.

On the borders of the Indian Ocean there are several species of these nummuline forms; and although they may vary slightly in their structural features here and there, for some of the "borders" are very wide apart (*ex. gr.* the Gulf of Aden and the south-west corner of Australia), still the genus extends to all of them; and therefore the Gulf of Manaar is not without its representatives, among which is the well-known *A. mammillata* of D'Orbigny. There is also another compressed globose form, unless it be the thick part of a *Heterostegina* worn down to this, with the same kind of structure as *Heterostegina*, and a third, which is the largest of all, wherein the chambers are extremely numerous and regular, closely approximated, awl-shaped, and much recurved, with a thick nummuline marginal cord between the whorls.

#### *Calcarina calcar*, var. *hispida*, n. var.

The same remarks respecting the varietal differences apply to *Calcarina calcar*, which is found in the Red Sea, at the Mauritius, and, under the form of *Trioporus baculatus*, in Polynesia, while it is also abundant in the Gulf of Manaar, but here under the hispid form mentioned. This hispid state bears the same relation to *Calcarina calcar* as the hispid form of *Calcarina Spengleri* bears to the latter species in Polynesia, well shown in Dr. Carpenter's representation ('Introduction,' pl. xiv. fig. 6). All, not averaging more than 1-24th inch in diameter, are much smaller than *C. Spengleri*, while it is not unusual to find the hispid form of the latter, like that of the former, sunk into the flat surface of an articulation of *Flabellaria opuntia* side by side with *Gypsina vesicularis*.

#### *Alveolina sinuosa*, n. sp. seu var.

The genus *Alveolina* also occurs on the borders of the Indian Ocean generally; but whether that from the south-west coast of Australia has been named or not I cannot say. Suffice it to state, then, that if so, *A. sinuosa* must be considered a variety; for I can see very little difference between it and that which occurs on the coast of Australia, as well as the

others that I have found about the Melobesian nodules of the Gulf of Manaar, beyond its larger size and sinuous form, it being a quarter of an inch long by 1-24th inch in its greatest transverse diameter.

*Hydroid Zoophyte.*

Family **Hydractiniidæ**, Hincks.

**HYDRADENDRIUM**, n. gen.

*Gen. char.* Polypary dendriform; stem solid, with the exception of a small medullary canal, thickly spined.

*Hydradendrium spinosum*, n. sp.

(Pl. XIX. fig. 8, *a-g*.)

Polypary dendriform, slender; stem erect, branched; branches alternate, about 1-24th inch apart, irregular in length and disposition around the stem, extending upwards and outwards from the fixed to the free end, becoming shorter towards the latter; sometimes subdivided, but generally giving off on each side a regular series of branchlets, arranged alternately and plumosely, from which again spring sparsely a third set, chiefly on one side. Consistence horny. Colour dark amber, translucent (Pl. XIX. fig. 8). Stem and branches smooth, except where interrupted by the presence of spines; the latter also smooth and directed upwards and outwards, in longitudinal lines, wherein they are arranged alternately in adjoining rows, the rows increasing in number with the size of the stem; spine round, conical, slightly curved upwards, varying in size from a slight indication at the growing ends of the branches respectively to 1-200th inch in length where fully developed (fig. 8, *b-f*). Stem solid, with the exception of an axial canal which traverses continuously every part of the structure, and contains the sarcode upon which the whole has been developed; hence at the extremities of the branches the latter is thicker in proportion to the horny material than at any other part (fig. 8, *c, d*), composed of concentric layers through which branches radiate from the axial canal to the branches themselves and to the spines respectively (fig. 8, *c*), terminating in the latter a little distance from the point, which is therefore imperforate and itself formed by concentric layers on the branch of sarcode first emanating from the medullary or axial canal (fig. 8, *e*). Diameter of largest fragment of stem found 1-90th inch, that of the axial canal in the same 1-600th inch. Coenosarc covering the surface of the skeleton, but not now elementarily distinguishable, on account of the specimen having been dried. Spine often bifid, but where

developed from the cœnosarc extending over foreign substances enlarged, dichotomously branched one or more times, and thus rendered dendriform (fig. 8, *a, g*). Largest and most perfect specimen, which is that figured, about 2 inches long and  $1\frac{3}{4}$  inch in its broadest part; stem of the same at the lower end, which has been broken off, 1-60th inch in diameter.

*Hab.* Marine, growing on hard objects.

*Loc.* Gulf of Manaar, in 65 fathoms, N. lat.  $7^{\circ} 18'$ . Western coast of Ceylon.

*Obs.* It may seem premature to some to establish a new genus of Hydractiniidæ on the mere skeleton of a Hydroid Zoophyte; but the characters of the family are so peculiar that, to those acquainted with the species which have been described, there is little risk of error in this respect. The generic distinction, however, is founded on the solidity of the structure, which in all other instances hitherto noticed is formed of reticulated fibre, like that of *Hydractinia echinata*. From the number of fragments of *Hydradendrium spinosum* among the Manaar dredgings, it would appear to be very plentiful in this locality. Under the microscope, when fully divested of the cœnosarc, the regularity of the spination and clear amber-colour of the whole stem, make it a beautiful object. In development, of course, the skeleton is formed upon the embryonic sarcode, which thus becomes separated from the cœnosarc of the exterior, although it is probable that subsequently the latter, which must have sprung from the former too, in the first instance, adds the greater portion of the horny material in layers, like the sarcode of the sponges to their structures both horny and siliceous. That the cœnosarc can do this is proved by the forest of dendriform spines which it develops from its surface when extending from the stem to other bodies, as shown in the illustrations (fig. 8, *a & g*).

## EXPLANATION OF THE PLATES.

### PLATE XVIII.

*Fig. 1.* *Polytrema cylindricum*, n. sp., *in situ*, showing the sponge-spicules projecting from the apertures in the ends of the branches respectively: *a*, horizontal section, to show the cortical and medullary cell-structure (magnified 2 diameters); *b*, form of cell about the ends of the branches, broken open; *c*, aperture with sponge-spicules on their way to the interior; *d*, the same in the interior; *e*, portion of surface of pillar, to show the arrangement of pores &c.; *f*, fragment of outer wall of cortical cell, cut horizontally to show the sunken pore-tubules; *g g*, tubules. (All on scale of 1-48th to 1-1800th inch.)

*Fig. 2.* *Tubipora reptans*, n. sp., *in situ*, showing the calyces and their

stolon (magnified 2 diameters). *a*, calycle, with portion of stolon cut off to show the vertically compressed form of the latter and cavity respectively; *b*, vertical section of stolon; *c*, compressed cavity; *d*, lateral view of tentaculated head when restored to position (ideal); *e*, end view of same sunk into the calycle: all relatively magnified on the scale of 1-144th to 1-1800th inch. *f*, form of young spicule; *g*, matured form (diagrams). *h*, fragment of the corallum, to show pore-openings between the calcareous tubipora-spicules, now otherwise consolidated; *i*, fragment of siliceous sponge-spicule imbedded in the same: scale 1-48th to 1-1800th inch. *k*, sponge-spicules imbedded in the corallum at the bottom of the calycle, as seen on looking down through the end of the latter (diagram).

*Fig. 3. Polytrema mesentericum*, n. sp., nat. size of specimen. *a*, portion of mesenteriform lamina, to show—*b*, pore-surface on the sides and, *c*, cortical and medullary cell-structure in the horizontal section: magnified 2 diameters. *d*, horizontal section of fragment, more magnified, to show—*e e*, pore-tubules, *f f*, cortical cells, and *g*, medullary cell-structure; *h*, fragment of surface, to show pore-openings (diagrams).

*Fig. 4. Holocladina pustulifera*, n. sp., suspended across a crevice in the Melobesian nodule, into which the ends of the branches are for the most part inserted, therefore represented as cut off (magnified about 16 diameters). *a*, average natural size. *b*, end view of large pustuliform eminence; *c*, the same, lateral view; *d*, the same, with summit extended into a spinous form: scale 1-24th to 1-1800th inch. *e*, end of branchlet, much magnified, to show the distribution and unequal size of the pustuliform eminences, also *f*, the structure and thickness of the test, *g g*, the conical, and *h*, the amorphous terminations respectively (diagrams).

*Fig. 5. Cystodictyina compressa*, n. sp., in contact with the surface of the Melobesian nodule, represented as cut off at each end where the continuation of the circumference was not seen (magnified about 16 diameters). *a*, average natural size; *b*, fragment of surface, much magnified, to show the prismatic structure of the pore-tubulation; *c*, end of circumferential lobule, much magnified, to show thinness of test and punctate surface, also *d d*, conical, and *e e*, amorphous terminations respectively (diagrams).

#### PLATE XIX.

*Fig. 6. Ceratestina globularis*, n. sp. *a*, embryonic or primary cell; *b*, terminal cell or chamber; *c*, connecting stolon; *d d*, crooked and knotted stolonie tubulations put forth by the last chamber; *e*, microspinous processes on the surface of the chamber; *f*, groups of *Ceratestina* on the surface of old *Stylaster sanguineus* from the S. Pacific Ocean; *g*, aperture of terminal cell: scale 1-24th to 1-1800th inch.

*Fig. 7. Ceratestina tessellata*, n. sp. *a*, globuliferous or adenoid portion; *b*, stolonie tubes: magnified about 16 diameters. *c*, commencement of the growth of a globuliferous portion on a stolonie tube; *d*, globuliferous portion, much magnified, to show meridianate or crossing lines of fibre in the horny wall, producing the tessellated appearance; *e*, stolonie portion; *f*, internal processes; *g*, end of stolon, more magnified, to show that it also

presents the tessellated appearance; *h*, tesseral division, much magnified, to show microspinous processes (diagrams).

*Fig. 8. Hydradendrium spinosum*, n. gen. et sp., natural size of specimen. *a*, growth of dendriform spines (see *g*); *b*, portion of stem, much magnified, to show rows of spines, viewed laterally; *c*, horizontal section of stem and spines, to show that the stem is composed of concentric laminae developed on *d*, the axial canal, from which *pari passu* are developed the spines: scale 1-48th to 1-1800th inch. *e*, spine, much more magnified, to show that it also is composed of concentric laminae, but solid and imperforate towards the free end; *f*, end of branch, to show commencement of spinal development on the medullary sarcode: scale 1-24th to 1-1800th inch. *g*, dendriform growth of spines produced by the coenosarc (see *a*): scale 1-48th to 1-1800th inch.

[To be continued]

XLI.—*On a Collection of Crustacea from the Malaysian Region*.—Part IV. Penæidea, Stomatopoda, Isopoda, Suctorioria, and Xiphosura. By EDWARD J. MIERS, F.L.S., F.Z.S.

[Plate XV.]

[Concluded from p. 384.]

*PENÆIDEA*.

*Penæus avirostris*, Dana.

W. Borneo.

I refer to this species two female specimens of *Penæus* in the collection. They agree with Dana's description in the form of the rostrum, fifth ambulatory legs, &c. In both the rostrum is prolonged backward into a somewhat indistinct median dorsal carina, which, however, is obsolete near the posterior margin. The rostrum, in the only perfect specimen, is 7-toothed above.

This species was not represented in the Museum collection when I wrote my analytical table of the species of *Penæus* (P. Z. S. 1878, p. 306); and the examination of the foregoing examples shows that it should be classed (in that synopsis) in the neighbourhood of *P. monoceros* and *P. Dobsoni*, on account of the distinct dorsal ridge of the carapace.

*Penæus sculptilis*, Heller.

W. Borneo (a female).

This specimen agrees very well with the description and figure of Heller, based on examples from Java. Like the

preceding it has been hitherto a desideratum to the Museum collection\*.

There is also in the collection a small specimen of *Penæus* which, on account of the imperfection of the rostrum, I cannot at present determine with certainty.

*Stenopus hispidus*, Latr.

New Guinea (an adult female of large size).

STOMATOPODA.

*Lysiosquilla maculata* (Fabr.).

Goram (a young male).

*Squilla nepa*, Latr.

West Borneo (an adult female).

*Pseudosquilla ciliata* (Fabr.).

New Guinea (an adult female).

\* The following additional species have been lately received by the British Museum:—

*Penæus Macleayi*, Haswell.

A specimen has recently been purchased (together with one of *P. canaliculatus*) from Mr. A. P. Goodwin, who collected them at the mouth of the Richmond River, New South Wales. Mr. Haswell's types were from Port Jackson. This species, with several others still desiderata to the Museum, has been described by him since the publication of my paper. Its place in the classification is in the vicinity of *P. affinis* and *P. avirostris*.

*Penæus Joyneri*, sp. n. (Plate XV. figs. 8–10.)

Carapace more or less pilose above, with the antennal and gastrophilic sulci faintly indicated; no pterygostomial spine. Rostrum nearly straight, acute, slender, and not reaching to the end of the antennal scale, armed above with seven or eight teeth, of which the posterior three are situated on the carapace behind its anterior margin, the last being separated from the rest by a wider interval; the anterior third of the upper margin and the lower margin are without spines. A longitudinal median dorsal line on the surface of the carapace indicates the obsolete dorsal ridge; and a similar line exists on the first three postabdominal segments. The first segment has a rounded tooth on each lateral margin. The fourth to sixth postabdominal segments are acutely carinated above. The terminal segment has a longitudinal median groove on its dorsal surface; its lateral margins are without spines; and its distal end is produced and acuminate. The eyes are large, the antennular flagella very short; the exognathi of the outer maxillipedes scarcely reach beyond the end of the penultimate joint. The second joint of the first and second legs (in the male) is armed with a spine



*Gonodactylus scyllarus* (Linn.).

Amboina (an adult male), Goram (an adult male), New Guinea (a male), Lette Island (a female?).

The specimens from New Guinea and Lette Island approach *G. Bleekeri*, A. Milne-Edwards, in having the median dorsal carina of the terminal postabdominal segment more elevated and acute; but the rostrum, although acute, is not more produced at its distal end than in the typical *G. scyllarus*.

*Gonodactylus chiragra* (Fabr.).

Java, Karangbollong (an adult female), New Guinea (an adult male), Amboina (a small male), Celebes, Macassar (an adult female).

The largest specimen (that from New Guinea) measures fully 4 inches from the tip of the rostrum to the terminal segment. The dilatation at the proximal end of the dactylus is of a pinkish tinge shading into blue; the distal end of the dactylus is always more or less inflexed.

*Gonodactylus graphurus*, White.

Amboina (an adult male). A male of small size is in the collection without special locality, in which, however, the genital appendages are perfectly developed.

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on the under surface; the third legs, in place of this spine, are armed with a straight and slender styloform appendage, which reaches to the middle of the merus joint, and is furnished at its distal end with a spear-like head, which is acute in front, laterally dilated and produced posteriorly; the merus joint of the fourth legs is dilated, carinated, and armed with a strong tooth in the middle of its inferior margin. This joint in the fifth legs, which are slender and much elongated, is less dilated, but distinctly toothed (see the figures). In the female, the third legs are armed only with a small spine. Length of the single male about  $4\frac{1}{3}$  inches.

*Hab.* Yokohama, Japan (*H. Batson Joyner, Esq.*).

Several specimens are in the collection.

I have much pleasure in associating this species with the name of its discoverer, who presented it, with several other interesting forms, to the British Museum. The peculiarity in the structure of the third to fifth ambulatory legs in the male, and particularly the remarkable appendages to the basis joints of the second legs (which, it may be presumed, serve as claspers during the act of coition), distinguish it from its congeners; but both sexes are further distinguishable by the form and dentition of the rostrum, and of the laterally unarmed terminal segment. It is allied to *P. avirostris*, Dana, and *P. Mastersii*, Haswell; but in the former species the rostrum is much more strongly carinated above, and in the latter the terminal segment is not acuminate; both, moreover, have a distinct dorsal carina on the carapace.

*Gonodactylus trispinosus*, White.

Amboina (an adult female).

This example agrees in all particulars with the two in the Museum collection from Sharks' Bay, W. Australia, which differ somewhat from the type (from Swan River) in the larger tubercles of the terminal segment, and the more numerous and regular denticulations of its posterior margin. The terminal segment is scantily clothed with short hairs.

## ISOPODA.

The Isopoda in Dr. Bleeker's collection were nearly all contained in a single bottle, without any special indication of locality. Upon examination, however, this bottle was found to contain fourteen out of the sixteen species described by him in his memoir on the Malaysian Cymothoidæ, already referred to\*.

Two or three other species, which are not included in that paper, were also found in the collection, and are described or referred to below.

In several of the species, and particularly in the large series of specimens of *Cymothoa Leschenaultii*, can be traced the gradual modification of the external sexual organs, accompanying the transformation of the young male individual into the fully-grown and perfectly-developed female, as detailed by Bullar† and Dr. P. Mayer‡, in their recent important researches demonstrating the existence of hermaphroditism and illustrating the various stages of development in the parasitic Cymothoidæ. Further details are given below, under the heads of the different species.

## ONISCIDEA.

*Ligia Gaudichaudii*.

? *Ligia Gaudichaudii*, M.-Edw. Hist. Nat. Crust. iii. p. 157 (1840);

? Gay, Hist. Chile, iii. p. 265 (1849); ? Dana, Cr. U.S. Expl. xiv. p. 741, pl. xlix. fig. 6 (1853).

A considerable number of specimens without definite locality are in the collection, which agree very well with the description and figure of Dana. Unfortunately in all of these the antennæ are imperfect and the uropoda are wanting. An

\* "Sur les Isopodes Cymothoadiens de l'archipel Indien," in Acta Societatis Scient. Indo-Neerlandicæ, ii. (1857).

† Journ. Anat. Physiol. xi. p. 118 (1876).

‡ Mittheil. Zoolog. Stat. Neapel, i. (Heft 2) p. 165 (1879).

example belonging to the same species is in the British-Museum collection from Madgica Sima.

Whether this be the *L. Gaudichaudii* of Milne-Edwards must remain somewhat uncertain, on account of the brevity of his description; the habitat of his types was probably Chilian.

#### CYMOTHOIDEA.

##### *Cymothoa Leschenaultii*.

*Cymothoa Leschenaultii*, Leach, Dict. Sci. Nat. xii. p. 352 (1818).

*Cymothoa Stromatei*, Bleeker, Acta Soc. Sci. Indo-Neerland. ii. p. 35, pl. ii. fig. 13 (1857), ad. ♀.

*Cymothoa Edwardsii*, Bleeker, t. c. p. 34, pl. ii. fig. 12 (1857), jun. ♂.

This species would appear to be one of the commonest of the Malaysian Cymothoidea, if one may judge from the very large series in the collection. I have observed a considerable variation in the form of the antero-lateral lobes of the first segment of the body and of the basis joint of the last pair of legs, and can see no sufficient reason for regarding Bleeker's species as distinct from the *Cymothoa Leschenaultii* of Leach, of which, unfortunately, only a single specimen from Pondicherry is in the collection. Adult and full-sized examples of this species are nearly  $1\frac{1}{2}$  inch in length; and amongst these are many in which the brood-pouch is fully developed; but there are not a few others, scarcely inferior in size, in which no trace of it exists. Two or three specimens are in the collection (length of the largest  $1\frac{1}{3}$  inch), exhibiting that interesting transitional stage in the development of the animal, recently described by Prof. Schiödte (see Ann. & Mag. Nat. Hist. ser. 5, ii. p. 196), during which copulation takes place, and in which the ovigerous pouch is developed upon the three posterior segments of the body only. The largest of the specimens, in which the external genital organs of the male are developed upon the ventral surface of the seventh thoracic segment, measures a little over 1 inch in length; but the majority are much smaller, some not exceeding half an inch. These agree in all essential characters with *C. Edwardsii* as described by Bleeker, which, therefore, I doubt not, was founded on the younger male form of the species. The adult female form of the species is apparently not invariably to be distinguished by its greater size; for there is in the series one example which does not seem specifically distinct, although of somewhat abnormal growth, which bears ova in the perfectly formed brood-pouch, yet measures only  $\frac{3}{4}$  inch in length.

*Cymothoa irregularis*, Bleeker.

Of this species (which, according to Dr. Bleeker, is common on fishes in the seas of Amboina) a good series is in the collection, including several specimens in which the brood-pouch is well developed (length of the largest 1 inch), and others in which it does not exist; but in these examples no external male organs are observable; the largest is about 8 lines. Even in the smallest the characteristic lunate form of the first thoracic segment is very apparent.

There is a specimen in the Museum collection, apparently referable to the *Cymothoa rhinoceros* of Bleeker, which certainly cannot remain in the genus *Cymothoa*; but, on account of its very mutilated condition, I cannot refer it with certainty to any described genus. It has neither male nor female external genital appendages. The head is transverse, eyes of moderate size; rostrum reflexed at tip, interantennal process small, and not dividing the upper antennæ at base, the first joints of the upper antennæ are not greatly dilated; the lower antennæ broken, but evidently reaching beyond the posterior margin of the first thoracic segment. The so-called epimeræ or coxal joints of the second to seventh legs are distinct. The basis joints of the legs are not dilated, and the terminal claw small but strongly curved; terminal segment triangular, and uropoda with the inner ramus the larger and somewhat obovate, outer slender, but not acute at apex.

*Anilocra marginata*.

*Cymothoa marginata*, Bleeker, Isopodes Cymothoadiens, in Acta Soc. Scient. Indo-Neerland. ii. p. 36, pl. ii. fig. 14 (1857).

Two specimens are in the collection. According to Bleeker it is found on fish in the seas of Batavia. This species must, I think, be placed in the genus *Anilocra*, on account of the linear form of the basis joints of the ambulatory legs. The violet band on the posterior margin of the body-segments is in these specimens (that have long been immersed in spirits) of a brown hue. The larger example (length 11 lines) is a fully-developed female; the smaller (length about 7 lines), without brood-pouch, has yet some traces of the median prominences of the seventh thoracic segment, characteristic of the male.

*Anilocra dimidiata*, Bleeker.

A large number of specimens are in the collection, nearly all of which are fully-developed females. It lives, according to Dr. Bleeker, on different fishes in the seas of Batavia.

The length of a full-sized specimen is about  $1\frac{1}{3}$  inch, of one of the smallest (with brood-pouch) about  $\frac{3}{4}$  inch. There are one or two specimens in which neither brood-pouch nor external male organs exist (length of the largest  $\frac{5}{8}$  inch).

*Anilocra alloceræa*.

? *Anilocra leptosoma*, Bleeker, *t. c.* p. 30, pl. i. fig. 6 (1857).

*Anilocra alloceræa*, Kölbel, Sitz. Ak. Wien, lxxviii. p. 407, pl. ii. fig. 1 (1879).

Four specimens, females, are in the collection. In one only of these are the antennæ and uropoda in a perfect condition. The first pair of antennæ agree exactly in the form of their fourth and fifth joints with Kölbel's excellent description and figure. In every other respect they so closely resemble the *Anilocra leptosoma* of Bleeker, that I at first assigned them without hesitation to that species; and I am even now inclined to regard it as probable that Bleeker's remarks and figure of the antennæ may be inaccurate, and the two forms really referable to one and the same species; and this I think the more likely, as the two species inhabit the same geographical region. Bleeker, it may be observed, notes that the uropoda in *A. leptosoma* do not reach beyond the extremity of the terminal postabdominal segment; in his figure, however, they are represented as distinctly longer than this segment, in this particular agreeing both with Kölbel's description of *A. alloceræa* and with the specimen before me\*.

\* I may take this opportunity of noting that the larger of the two original examples of *Ceratothoa trigonocephala* (*Cymothoa trigonocephala*, Leach, and the one which bears his MS. label and must be considered as the type) differs from *C. trigonocephala* as figured by Kölbel (pl. i. fig. 3), and resembles *C. oxyrhynchena* of that author, in the form of the head (which has the lateral margins straight and the front acute) and in the form of the antero-lateral processes of the first segment of the body, which in a lateral view are rather broad, and in a dorsal view appear narrowed at their apices. It differs from *C. oxyrhynchena*, however, in the form of the penultimate postabdominal segment, which has the posterior margin sinuated in the middle and on each side, and therein agrees with Kölbel's description of the specimens he refers to *trigonocephala*. Length  $1\frac{2}{3}$  inch.

The smaller example (length  $10\frac{1}{2}$  lines) agrees more nearly with Kölbel's figure of *C. trigonocephala* in having the lateral margins of the head slightly sinuated and the front less acute; the apices of the antero-lateral processes of the first segment of the body, however, are narrowed both in a lateral and dorsal view; the form of the penultimate postabdominal segment sinuated, as in the larger example. As the exact localities of these examples are not known, it is difficult to determine whether the two belong to distinct species, or whether the differences indicated by Kölbel are not perhaps rather to be regarded as of less than specific value. The basis joint of the seventh pair of legs is, in both specimens, much less dilated posteriorly than in *C. oxyrhynchena*.

## RENOCILA, gen. nov.

Allied to *Anilocra* in most of its characters; but the 8-jointed superior antennæ are greatly developed, reaching nearly to the posterior margin of the first thoracic segment, with all the joints (the terminal excepted) more or less dilated and compressed, so as entirely to conceal the very small inferior antennæ; the dilatation is greatest in the third joint (the second visible in a dorsal view), the following joints becoming successively smaller. The inferior antennæ are small and 7-jointed, reaching nearly to the end of the fifth joint of the upper antennæ. The eyes are small and indistinct, and placed near the postero-lateral angles of the head, which is truncated anteriorly; the front not produced inferiorly, so as to conceal the bases of the antennæ. The fifth to seventh thoracic segments are greatly prolonged backward at their postero-lateral angles, so as (in the sixth and seventh segments) entirely to conceal the "epimeræ" or coxal joints; the postero-lateral lobes of the seventh thoracic segment reach beyond the base of the terminal postabdominal segment. The coxal joints of all the legs are posteriorly acute; those of the second to fifth legs well developed and visible in a dorsal view. None of the legs have the basis joints dilated; and all terminate in very strong curved claws. The uropoda do not reach to the posterior margin of the transverse posteriorly-rounded terminal segment, and are furnished with slender rami, the outer of which is a little longer than the inner.

This genus, in all its characters, is most nearly allied to *Anilocra*, from which it is distinguished by its broad non-inflexed front, the greatly produced postero-lateral angles of the three posterior thoracic segments, and the greatly dilated superior antennæ.

*Renocila ovata*, sp. n. (Pl. XV. figs. 11-14.)

The body is moderately convex, ovate; the head, which is scarcely broader than long, has the posterior margin rounded, and the sides slightly convergent to the straight anterior margin, which is inflexed, but not produced so as to conceal the bases of the antennæ. The first thoracic segment is a little longer than the two following, and its postero-lateral angles are slightly prolonged backward and rounded; the two following segments are not so produced; in the fourth segment the postero-lateral lobes are very small, in the fifth to seventh segments they are (as stated above) greatly developed, not acute, but rounded at the distal ends, and with the

lateral margins slightly reflexed; the first five postabdominal segments are very short, and are not laterally produced; the terminal segment is almost semicircular in outline, smooth above, with a longitudinal median raised line on its upper surface. The second joint of the antennæ (in a dorsal view) is considerably enlarged and nearly quadrate; the following joints (except the last) of a similar form, but successively smaller, the terminal minute and slender. The penultimate and antepenultimate joints of the inferior antennæ are slenderer and more elongated than the preceding, the terminal is minute. The coxal joints of the second to fifth legs become successively more acute; those of the sixth and seventh legs are acuminate and spiniform (in an inferior view). None of the basis joints of the thoracic legs are dilated or distinctly carinated; the rami of the uropoda are slender and rounded at the distal ends. Length of the larger example about 11 lines, breadth  $5\frac{1}{2}$  lines.

Two specimens are in the collection, both presenting the characters of the female sex, the brood-pouches being developed. The length of the smaller is 8 lines.

The dilatation of the antennal joints is analogous to that characteristic of the genus *Ceratothoa*; but the antennæ are remote from one another at their base.

*Lironeca emarginata*, Bleeker.

This species is represented in the collection by a single specimen (a female) of large size (nearly 1 inch 4 lines).

The *Lironeca laticauda* described by me (P. Z. S. 1877, p. 677, pl. lxix. fig. 5) from Manchuria is distinguished by the form of the front, which is not produced, by the much broader coxal joints of the thoracic legs (which are not fully exhibited in the dorsal view of the animal given in the figure cited above), and the more dilated basis joints of the three posterior pairs of thoracic limbs.

*Lironeca Renardi*, Bleeker.

Of this species (as of the preceding) there is in the collection only a single specimen (a female). The strongly-lunate form of the first segment of the body, with its projecting antero-lateral lobes, gives it a resemblance to *Cymothoa irregularis*. Length  $\frac{2}{3}$  inch (8 lines). Both this and the preceding species are stated by Bleeker to have been taken from the skin of various fishes inhabiting the sea of Batavia. *L. Renardi* bears a considerable resemblance to the freshwater *L. daurica*, described by me (*l. c.* p. 676, pl. lxix. fig. 4)

from the River Onon, in Dauria, South-eastern Siberia, but may be distinguished by the form of the coxæ, which in *L. Renardi* extend along the whole length of the lateral margins of the segments of the body to which they are respectively attached. Of *L. Renardi* there is in the Museum collection a female taken from a species of *Mugil* inhabiting the Indian seas (*Dr. F. Day, F.L.S.*).

*L. daurica* is very closely allied to *L. Jellinghausii* (*Ichthyoxenus Jellinghausii*, Herklots, Arch. Néerlandaises, v. p. 128, pl. v. fig. 10–18) from the fresh waters of Java, with which I should be inclined to unite it, were it not for the widely separated localities of the two species, as it apparently differs in nothing but the somewhat shorter uropoda of the penultimate segment.

I have no information as to whether *L. daurica* penetrates the body of its host behind the ventral fins, as does *L. Jellinghausii*. Except for its peculiar habitat, I can see nothing to distinguish *Ichthyoxenus* from *Lironeca*; but because Herklots had described the Javan species as a distinct genus I did not suspect its affinity with the Daurian form when I described the latter.

It does not appear that a generic character can be found in the position of the coxæ, *i. e.* their insertion in the angles between the thoracic segments, since Herklots notes a variation of this character in specimens he considers to be males of *L. Jellinghausii*.\*

#### *Lironeca Boscii*, Bleeker.

A considerable series is in the collection. The largest example (length about 10 lines) exhibits the characters of the male sex, and is the only one in which they are distinctly observable. The greater number are well-developed females, the largest being about 9 lines long ( $\frac{3}{4}$  inch).

*Lironeca ornata*, Heller, from Sambelong, is a nearly allied form, but is distinguished by the triangular terminal segment, which is produced greatly beyond the extremity of the rami of the uropoda.

\* Closely allied species are in the Museum collection from the Mauritius (*R. Templeton, Esq.*), designated, but not described, by White as *Cymothoa micronyx*, and from Australia (*Earl of Derby* and *J. B. Jukes, Esq.*), as *Cymothoa contracta*. *Lironeca contracta* is apparently distinguishable by the much broader, more dilated basis joints of the four posterior thoracic limbs and subacute rostrum, *Lironeca micronyx* by the transverse terminal segment and the less marked carina of the posterior thoracic limbs; the specimens of the latter species, however, are much shrivelled from having been preserved in a dry state. In all of the above the coxæ are inserted in the angles between the thoracic segments.



*Lironeca lata*, Dana, from the Sandwich Islands, seems to be in some degree intermediate between this species and *L. emarginata*, as in it the head is somewhat more deeply encased in the first segment of the body, but the terminal segment does not project beyond the extremity of the uropoda.

*Lironeca pterygota*, Kölbel.

This species is represented in the collection by a single specimen of very small size (length  $4\frac{1}{2}$  lines) found among specimens of *Nerocila phaeopleura*. It agrees with Kölbel's description in all respects, except in the somewhat longer antennæ, the superior pair reaching to the posterior margin of the head, and the inferior pair to the middle of the lateral margins of the first thoracic segment. The very unequal development of the coxæ (those of the convex side of the body being much the larger) would seem to distinguish it from *L. Boscii*, to which, in its distorted form, it bears much external resemblance.

*Nerocila trivittata*, Bleeker.

This species, which, according to Dr. Bleeker, inhabits the seas of Amboina, is represented in the collection by a single specimen (a female, length nearly 9 lines). Dr. Bleeker's description was drawn up from a unique specimen; but the example before me is probably not the one figured by him, which is of larger size and may have been one obtained subsequently.

*Nerocila phaeopleura*, Bleeker.

A large series of specimens are in the collection, of which the greater number are females with well-developed brood-pouches. Length of a full-sized example 1 inch, of one of the smallest 7 lines. There are several specimens in which no brood-pouch exists; but in none of these have I observed external male organs. Length of one of the largest 9 lines.

*Nerocila dolichostylis*, Kölbel, is a nearly allied form, but distinguished by having the postero-lateral angles of all the segments produced into spines. In *N. phaeopleura* usually only the first and seventh segments are thus produced.

*Nerocila laevinota*, sp. n. (Pl. XV. figs. 15, 16.)

Body narrow-oval, about two and a half times as long as its greatest breadth, rather convex. Head with the frontal margin produced, rounded, and concealing the bases of the antennæ. Thoracic segments with their tergal portions smooth, and in no case produced at the postero-lateral angles;

the coxal joints of the second to fifth legs are posteriorly acute, but not produced beyond the postero-lateral angles of the segments; those of the sixth and seventh legs are more elongated, and form distinct spines. The lateral prolongations of the second (first exposed) and third postabdominal segments are elongated, laterally compressed, and acute; those of the fourth to sixth segments do not exceed half the length of the preceding; the terminal segment is large, flat, with the sides straight and parallel, with its distal end rounded, and with a longitudinal median raised line in the middle of its upper surface. The eyes are placed close to the postero-lateral angles of the head; the anterior antennæ are 8-jointed, reach a little beyond the posterior margin of the head, with the basal joint enlarged and subglobose; the posterior antennæ also are about 8-jointed. The dactyli of the four anterior thoracic legs are long and strongly curved; the rami of the uropoda unequal, the outer the longer and straight, the inner with a distinct tooth on its inner margin and with the distal extremity acute. Length about 1 inch.

West Borneo (an adult female).

The absence of tergal spines, the form of the coxæ and of the rami of the uropoda suffice to distinguish this species from its congeners. It is perhaps most nearly allied to *Nerocila aculeata*, an Indian species described by Milne-Edwards; but in this species the postero-lateral angles of the thoracic segments are produced into distinct spines.

A specimen from the Malabar coast in the British-Museum collection is allied to both *N. aculeata* and *N. levinota*, but apparently distinct from either. The length of the body barely exceeds twice its greatest breadth. The postero-lateral angles of the tergal portions of the fifth to seventh thoracic segments are produced into small distinct spines, as in *N. aculeata*; the form of the lateral prolongations of the segments of the postabdomen and of the uropoda, however, is nearly that of *N. levinota*. It is distinguished from both species by the great development of the coxal spines of the sixth and seventh legs, which are acuminate and nearly twice as long as the segments themselves (see Pl. XV. fig. 17). This I will designate *N. longispina*. It is possible that a large series would show intermediate gradations between the three forms; but, apart from such evidence, they must be regarded as distinct\*.

\* *Nerocila congener* is a name applied by White, without description, to a remarkable species of this genus in the Museum collection from the Philippine Islands. It is distinguished by the form of the head, which has the anterior margin broadly rounded and produced, so as almost

*Nerocila (Emphyilia) sundaica*?

? *Nerocila sundaica*, Bleeker, *t. c.* p. 26, pl. i. fig. 4 (1857).

*Emphyilia ctenophora*, Kölbel, Sitz. Ak. Wien, lxxviii. p. 414, pl. ii. fig. 4 (1879).

This fine species is represented in the collection by five specimens (four of which are well-developed females). Length of the largest about  $1\frac{1}{4}$  inch; the smallest example (length 1 inch) has no brood-pouch. These agree with the description of Bleeker in all essential particulars, and also with that of Kölbel, whose excellent figure leaves me in little doubt of the identity of the specimens before me with his *Emphyilia ctenophora*. Bleeker's figure, however, differs in some important points; *e. g.* the basal joints of the antennæ are not represented as dilated, but of the form ordinarily characteristic of *Nerocila*, and the inner rami of the uropoda as somewhat sinuated and not shorter than the outer. In all other respects the figure seems to be a very fair representation of *Emphyilia ctenophora*. But in four out of five of the specimens of *N. sundaica* in the collection, the superior antennæ have their basal joints less dilated than in Kölbel's figure, and not in contact, but separated by an interval of varying width; moreover I have shown, in the case of *Anilocra leptosoma*, that the accuracy of the minuter details of Bleeker's plates is not always to be relied upon. Thus, also the outer rami of the uropoda of *Nerocila sundaica* are described by Bleeker as much longer than the inner (in this agreeing with specimens before me), although, as stated above, both rami are represented as subequal in the figure.

On account of the variation in the dilatation of the basal antennal joints, it seems to me doubtful whether the genus *Emphyilia* can be permanently maintained; but until a complete transition has been observed from it to *Nerocila*, it may be useful to retain it at least as a subgenus.

*Corallana macronema*.

*Æga macronema*, Bleeker, *t. c.* p. 23, pl. i. fig. 1 (1857).

Two specimens (males) are in the collection. Length of the largest 9 lines. These specimens must, I think, certainly be referred to *Corallana*, and the species placed near *C. basalis*

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completely to conceal both pairs of antennæ. The postero-lateral angles of the first segment of the body are produced into a small acute tooth, and those of the seventh segment into a broader less acute lobe. The coxæ of all the thoracic limbs are rather broad, posteriorly acute, but do not project greatly beyond the postero-lateral angles of their several segments. The uropoda are wanting. Length 1 inch 2 lines.

and *C. collaris*, in the classification recently proposed by Schiödte and Meinert (Nat. Tidsskr. p. 287, 1879), on account of the distinct but narrow linear interantennular process (*lamina frontalis*). The maxillipedes are slender, the basal portion not exceeding the terminal palpus in width, and the six anterior legs armed with a very small terminal claw.

SUCTORIA *vel* RHIZOCEPHALA.

*Sacculina rotundata*, sp. n. (Pl. XV. figs. 18, 19.)

The animal in outline is transversely oval, somewhat compressed, without any trace of the depression at the proximal end of the sac which characterizes several of the oriental species recently described by Kossmann (Arbeit. zool.-zootom. Inst. Würzburg, i. pp. 121-136, 1872-74).

The integument (unless microscopically examined) appears smooth, but is transversely wrinkled, on account, perhaps, of the long immersion of the specimen in spirits. On that surface of the sac which is applied to the sternum of the crab on which the *Sacculina* is parasitic are two wide and shallow concavities, separated by an obtusely rounded longitudinal median ridge which fits into the sternal suture (as in *S. corculum*). The opposite face of the sac (*i. e.* that applied to the abdomen of the crab) is regularly convex. The funnel-shaped oral aperture is moderately produced, and very similar to that of *S. corculum* as figured by Kossmann (*t. c.* pl. v. fig. 1 a); the distal aperture of the sac (*Mantelöffnung*) is placed on the sternal surface, and does not project at all from the plane of the body. Length 5 lines, breadth 7 lines.

A single specimen is in the collection, parasitic on a male example of *Eriphia levimana*, without definite locality.

I cannot identify it with any of the numerous described species; but as I have not had the opportunity of comparing it with any of Kossmann's types, it is with much hesitation that I regard it as distinct.

In most particulars this species is very nearly allied to *S. corculum*, Kossmann (*t. c.* p. 122, pl. v. fig. 1), parasitic on *Atergatis floridus* from the Philippines. It differs chiefly in the transverse oval, not cordiform shape of the sac. The integument is armed with numerous minute spicules, which are most abundant and conspicuous near the distal opening, but quite imperceptible except under the microscope. They seem to be rooted in the cellular tissue, beneath the outer cuticle, and furthermore differ from the spinules of *S. corculum*, and more nearly resemble the infracuticular spicules of *S. crucifera*, Kossmann, in being very slender, not broader at

base; their apices are somewhat blunt. Such, at least, is the form of spicules taken from the vicinity of the distal opening of the sac (Pl. XV. fig. 19).

## XIPHOSURA.

*Limulus moluccanus*, Latr.

An adult male.

*Limulus rotundicauda*, Latr.

An adult female.

There is in the collection a specimen of small size (length of carapace about  $1\frac{1}{4}$  inch) which probably belongs to this species. As in all young specimens I have seen, the spines of the dorsal surface of the cephalothoracic shield are considerably developed. None of the above has any special indication of locality.

## EXPLANATION OF THE PLATES.

## PLATE XIII.

- Fig. 1.* *Cycloceloma tuberculatum*, gen. et sp. nov. (nat. size).  
*Fig. 2.* Inferior view of buccal, antennal, and orbital region of the same ( $\times 2$  diam.).  
*Fig. 3.* Inferior view of part of the antennal and orbital region of *Liomera Rodgersii*, Stimpson ( $\times 4$  diam.).  
*Fig. 4.* *Pilumnopus granulatus*, sp. n. ( $\times 1\frac{1}{2}$  diam.).  
*Fig. 5.* Inferior view of buccal, antennal, and orbital region ( $\times 2$  diam.).  
*Fig. 6.* Outer view of chela of the unique example (a female) ( $\times 1\frac{1}{2}$  diam.).

## PLATE XIV.

- Fig. 1.* *Telphusa sumatrensis*, sp. n., ♂ ( $\times 1\frac{1}{2}$  diam.).  
*Fig. 2.* Outer view of larger hand of the same ( $\times 1\frac{1}{2}$  diam.).  
*Fig. 3.* Outer view of hand of *Sesarma granosimana*, sp. n., ♂ ( $\times 1\frac{1}{2}$  diam.).  
*Fig. 4.* Third maxillipede of *Pinnotheres obesus*, Dana? (considerably magnified).  
*Fig. 5.* *Matuta circuliifera*, sp. n., ♂ (nat. size).  
*Fig. 6.* *Eupagurus japonicus*, Stimpson? (nat. size).  
*Fig. 7.* Rostrum and ophthalmic scales of the same ( $\times 2$  diam.).  
*Fig. 8.* Coxæ of the fifth ambulatory legs of male *Canobita perlata*, var. *affinis*, n. ( $\times 2$  diam.).

## PLATE XV.

- Fig. 1.* Antero-lateral margins of *Dromia (Dromidia) orientalis*, sp. n., showing the form and disposition of the teeth (nat. size).  
*Fig. 2.* Sternal sulci of the same (nat. size).  
*Fig. 3.* Rostrum of *Atya moluccensis*, sp. n. (nat. size). 3 a, teeth of the inferior margin of the same (magnified).  
*Fig. 4.* Third cephalothoracic leg of the same (nat. size).

- Fig. 5. Rostrum of *Atya spinipes*, Newport?, from the Samoa Islands (nat. size). 5 a, teeth of the inferior margin of the same (magnified).
- Fig. 6. Third cephalothoracic leg of the same, showing the specific distinction between this species and *Atya moluccensis* (nat. size).
- Fig. 7. Lateral view of the second postabdominal segment of *Enoplometopus dentatus*, sp. n. (nat. size).
- Fig. 8. Basal portion of one of the third cephalothoracic legs of *Penæus Joyneri*, sp. n., showing the remarkable appendage of the second or basis joint ( $\times 2$  diam.).
- Fig. 9. Basal portion of fourth cephalothoracic leg of the same, showing the dilatation and inferior tooth of the merus joint ( $\times 2$  diam.).
- Fig. 10. Basal portion of the fifth cephalothoracic leg, showing the form of the merus joint ( $\times 2$  diam.).
- Fig. 11. *Renocila ovata*, gen. et sp. nov. ( $\times 1\frac{1}{2}$  diam.).
- Fig. 12. Head and antennæ of the same, dorsal view ( $\times 2$  diam.).
- Fig. 13. Inferior view of head, showing the form of the front and inferior antennæ ( $\times 2$  diam.).
- Fig. 14. Inferior view of postero-lateral lobe of the sixth thoracic segment, showing the position of the small coxa ( $\times 3$  diam.).
- Fig. 15. *Nerocila lævinota*, sp. n. ( $\times 1\frac{1}{2}$  diam.).
- Fig. 16. Lateral view of coxa of sixth thoracic leg ( $\times 2$  diam.).
- Fig. 17. Lateral view of coxa of the same limb in *N. longispina*, sp. n. ( $\times 2$  diam.).
- Fig. 18. *Sacculina rotundata*, sp. n. ( $\times 2$  diam.).
- Fig. 19. Spicules from the epidermis of the same, as seen under a  $\frac{1}{4}$ -inch objective.

XLII.—*Description of a new Bat from Java, of the Genus Kerivoula.* By OLDFIELD THOMAS, F.Z.S., Assistant in the Zoological Department, British Museum.

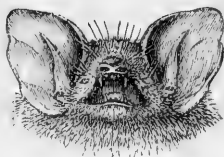
THE specimen upon which this description is based was obtained by Mr. H. O. Forbes at Kosala, near Bantam, Java, 2100 feet above the sea, on the 24th of September, 1879, and is now in the British Museum.

*Kerivoula javana*, sp. n.

Fur greyish black, each hair being nearly black for its proximal third, then white for the middle third, the end being black, with sometimes a shining white tip. Ears rather short; laid forward they reach to about halfway between the eyes and the tip of the nose. Shape of ears and tragus exactly as in *K. Jagori*\*, the former having the second small concavity in the middle of the outer edge, and the latter the deep horizontal

\* Peters, MB. Ak. Berl. 1866, p. 399; Dobson, Cat. Chir. B. M. p. 338.

notch above the external basal lobule described in that species, as shown in the woodcut. Distribution of fur as in *K. papuensis*\*, there being short shining yellowish hairs thickly set along the forearm, on the thumb quite to the claw, all along the second finger, on both phalanges of the third, and on the distal phalanges of the fourth and fifth fingers. There are also a few hairs on the proximal end of the fifth metacarpal. The tail and the hind limbs quite to the bases of the claws are covered with similar hairs; the edge of the interfemoral, however, is without a fringe. The teeth are quite similar to those of *K. papuensis*.



*K. javana* is thus intermediate between *K. Jagori*, a Philippine species, and *K. papuensis* from New Guinea, differing from the latter in the shape of the ears and tragus, and by the absence of an interfemoral fringe, and from the former by the presence of fur upon the limbs, that species having these quite naked†. It differs from both, however, in the tricolor character of the fur, as they are of a nearly uniformly dark reddish-brown colour, though the tips of the hairs are lighter.

Measurements of the type, an adult female in spirit:—Length, head and body 1''·93, tail 1''·72, head 0''·78, ear 0''·6, tragus 0''·37, forearm 1''·53, thumb 0''·27, third finger 3''·0, fifth finger 2''·2, tibia 0''·72, foot 0''·35.

XLIII.—*Notes on the Gasteropoda contained in the Gilbertson Collection, British Museum, and figured in Phillips's 'Geology of Yorkshire.'* By R. ETHERIDGE, Jun., F.R.Ph.S.Ed.

IN the 'Geological Magazine' for April 1879 (no. 178) I gave a few brief notes on the Bivalves contained in Gilbertson's collection of Carboniferous-Limestone fossils in the British Museum, and the majority of which were made the subject of illustration in the second volume of Phillips's work, 'Illustrations of the Geology of Yorkshire,' part 2, "The Mountain-Limestone District."

I now purpose following up this subject by an examination of the Gasteropoda, and in the present communication shall

\* Dobson, *tom. cit.* p. 339.

† Cf. Dobson, *tom. cit.* p. 332.

pass in review those species represented on pl. xiii. of the above work. Notes on the specimens of *Gasteropoda* illustrated by pls. xiv.-xvi. will be given in subsequent communications.

THE SPECIES FIGURED ON PLATE XIII. OF VOL. II., 'GEOLOGY OF YORKSHIRE,' BY JOHN PHILLIPS, F.R.S., F.G.S.

1. *Euomphalus pentangulatus*, Sowerby (Phillips, p. 225, t. 13. fig. 13).

This, by far the handsomest species of the genus *Euomphalus*, is well represented in Gilbertson's collection. The section figured in the above plate exemplifies in a particularly well-marked manner the peculiar septation and division into chambers which takes place in the older whorls of this species. With the view of studying this subject more fully, I have had a number of sections of various species made, and hope to speak on this subject at some future date. *E. pentangulatus* has been described in detail by Profs. de Koninck and M'Coy, and need not be again redefined. From *E. catillus* the present species is distinguished by its more convex back, more prominent whorls on the non-umbilicated sides, and by the *very* much less marked character of the ridge bounding the umbilicus as compared with that on the upperside of the shell. The manifest dissimilarity to *E. calyx* is at once apparent. I quite agree with Prof. M'Coy in considering the form established by Col. Portlock as *E. Bronni* only a variety of *E. pentangulatus*, in which the spire is elevated to a more or less greater degree above the keeled edge of the last whorl. The Gilbertson collection contains specimens of this variety. The present species is the

*E. pentangulatus*, J. Sowerby, Min. Conch. 1814, i. p. 97, t. 45 (2 upper figures).

*Skenæa perangulatus*, Fleming, Brit. Animals, 1828, p. 314.

*E. pentangulatus*, Bronn, Lethæa Geogn. 1835, i. p. 94, t. 2. fig. 2, *a, b*.

*E. pentangulatus*, Phillips (as above).

*Schizostoma catillus*, Fischer, Oryct. Gouv. Moscou, 1837, p. 129, t. 49. figs. 3, 4.

*E. Bronni*, Portlock, Geol. Rep. Londond. 1843, p. 417.

*E. quinquangulatus*, Goldfuss, Petref. Germ. pt. 3, p. 87, t. 191. fig. 3, *a-c*.

*E. pentangulatus*, M'Coy, Synop. Carb. Limest. Foss. 1844, p. 37; Bronn, Index Pal. Nomen. 1848, p. 480; Brown, Foss. Conchol. 1849, p. 81, t. 42. figs. 28, 29; M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 540; Morris, Cat. Brit. Foss. 1854, ed. 2, p. 248.

*E. quinquangulatus*, Eichwald, Lethæa Rossica, 1860, i. pt. 2, p. 1153.

*E. pentangulatus*, Römer, Lethæa Geogn. Atlas, 1876, t. 45. fig. 10, *a-c*.



2. *Euomphalus catillus*, Martin (Phill. p. 225, t. 13. figs. 1, 2).

The figure is drawn from a much fractured example, the breaks not being shown in the figures. The leading character of this species is the equally angulated ridge on each side of the back; at least it is said by most writers to be equal, although that on the lower or non-umbilicate side is usually somewhat sharper than the other, which has a tendency to become a little rounded like a marginal cord. The points of difference between this shell, *E. calyx*, and *E. pentangulatus* respectively have been well expressed by M'Coy. The section is quadrate, the back being the longest of the four sides. It is the

*Helicites catillus*, Martin, Petr. Derb. 1809, t. 7. figs. 1, 2.

*Euomphalus catillus*, J. Sow. Min. Conch. 1814, i. p. 98, t. 45. figs. 3, 4; Phillips, *loc. cit.*; De Koninck, Animaux Foss. p. 427, t. 24. fig. 10, a, b; Goldfuss, Petr. Germ. pt. 3, p. 87, t. 191. fig. 6, a-d.

*Straparollus? catillus*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 538.

*Euomphalus catillus*, Morris, Cat. Brit. Foss. ed. 2, 1854, p. 247; Eichwald, Lethæa Rossica, 1860, ii. p. 1153; De Koninck, Mon. Foss. Carb. Bleiberg, 1873, p. 103, t. 4. fig. 4.

3. *Euomphalus calyx*, Phillips (p. 225, t. 13. fig. 3).

The umbilicus in this shell is not so definitely shown as represented in the figure; it is more or less obscured by matrix, whilst the opposite side of the specimen is wholly imbedded in the limestone. Prof. de Koninck\* is quite in error in referring this species to *E. catillus*, Phill.; it is in no way a cast "of the spire of a specimen of *E. catillus*," the true shelly matter being retained over the whole of the specimen. The figures and descriptions of J. de C. Sowerby and Prof. M'Coy are quite conclusive on this point. The aperture is here more nearly triangular than in the last species, although it is decidedly four-sided. It is the

*Euomphalus calyx*, Phillips, *loc. cit.*; J. de C. Sow. Min. Conch. 1844, vii. p. 47, t. 633. figs. 8-10; Brown, Foss. Conch. 1849, p. 81, t. 42. fig. 23.

*Euomphalus tabulatus*, De Koninck, Animaux Foss. p. 429, t. 24. fig. 11.

*Straparollus? calyx*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 537.

*Euomphalus calyx*, Morris, Cat. Brit. Foss. 1854, ed. 2, p. 247.

4. *Euomphalus bifrons*, Phillips (p. 225, t. 13. fig. 4).

The Gilbertson collection contains three very well-marked examples of this shell. Phillips describes his species as with "whorls carinato-tuberculated above, obtusely angulated or

\* Animaux Fossiles, p. 428.

rounded below." There can, however, be no possible doubt that these examples, including the figured specimen, had tubercles on the lower side, as on the upper; these can even now be indistinctly traced by the naked eye, but are more distinctly perceptible to the touch on passing the finger round the edge of the large whorl. This fact was noticed by Mr. J. de C. Sowerby, who, writing some few years later than Prof. Phillips, says, in describing *E. pugilis*, "the tubercles beneath are sometimes very slightly prominent or irregular, when it approaches to *E. bifrons*, Phill. . . . and is probably a variety of it" \*. Later on Mr. Sowerby united the two forms under the name of *E. pugilis*, var. *bifrons* †. The shell figured by Phillips also served Mr. J. de C. Sowerby as his type; he expressly states that his illustration was taken from an example in the Gilbertson collection; and an inspection of the shells confirms this statement. I suspect this example has met with an accident since it was figured by Messrs. Phillips and Sowerby. It is in five pieces, no indication of which is shown on Mr. Sowerby's illustration; had such fractures existed they would have been shown, so very faithfully were all the representations throughout the 'Mineral Conchology,' as a rule, executed. The union of *E. bifrons* with *E. pugilis* was made by Prof. de Koninck, at much about the same time ‡ as proposed by Mr. J. de C. Sowerby; and in this they have been followed by Prof. M'Coy, who likewise drew attention to the resemblance of *E. tuberculatus*, De Kon. Notwithstanding the more elevated spire of this, I think it very probably only a variety of *E. bifrons* or *E. pugilis*, whichever name may be adopted. It is the

*Euomphalus bifrons*, Phillips, loc. cit.

*E. pugilis*, Phillips, tom. cit. p. 225; J. de C. Sow. Min. Conch. 1841, vii. p. 22, t. 621. figs. 2-4; var. *bifrons*, id. op. cit. 1844, p. 48, t. 633. fig. 2; De Koninck, Animaux Foss. p. 422, t. 25. fig. 4, a-c.

*E. pugilis* et *bifrons*, Goldfuss, Petr. Germ. pt. 3, p. 85, t. 190. figs. 4, a, b, and 5, a-c.

*Straparollus pugilis*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 541.

*Euomphalus pugilis*, Morris, Cat. Brit. Foss. 1854, p. 248.

##### 5. *Euomphalus pugilis*, Phillips (p. 225, not figured).

The Gilbertson collection contains two specimens of this variety of the foregoing species; neither of them, however, is that figured by Mr. J. de C. Sowerby§, nor can I find any specimen in the "Sowerby collection" corresponding with the figures in question.

\* Min. Conch. vii. p. 22.

† Ibid. p. 48.

‡ Animaux Fossiles, p. 422.

§ Min. Conch. vii. t. 621. figs. 2-4.

6. *Euomphalus cristatus*, Phillips (p. 225, t. 13. fig. 5).

This fine specimen was made the subject of a distinct genus, at a somewhat later date, by Mr. J. de C. Sowerby, under the name of *Phanerotinus*. Its characters, as compared with *Euomphalus* generally, are so anomalous that it could scarcely be retained in the latter with propriety. I therefore agree with Prof. Morris in the retention of the name for this species at least. The shell was of considerable thickness, and with its shelly outgrowths must have presented a handsome appearance. It is the

*Euomphalus cristatus*, Phill. loc. cit.

*Phanerotinus cristatus*, J. de C. Sow. Min. Conch. 1843, vii. p. 29, t. 624. figs. 1, 2; Morris, Cat. Brit. Foss. 1854, ed. 2, p. 267.

*Eccyliomphalus cristatus*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 542.

7. *Cirrus acutus*, J. Sowerby (Phillips, p. 225, t. 13. fig. 12).

As represented by Phillips the figured specimen is only a portion of a larger one; the position, however, in which it is placed is rather misleading. I cannot for a single moment agree with Prof. de Koninck in his statement that with the exception of the height of the spire this species has nearly all the characters of *E. pentangulatus*. In the first place, *Cirrus acutus* possesses no angulation on the underside of the body-whorl, which is a well-marked feature in *E. pentangulatus*; secondly, in the former the portion of the shell above the angulation of the body-whorl, on the upper surface, is flat or concavely bent upwards, whilst in the latter species the corresponding portion of the body or last-formed whorl is concave inwards and downwards. Now, if fragments of these shells are met with, these features would give to them a very great and marked difference. Further, this is repeated in each whorl of *E. pentangulatus*, making it therefore constant; whereas in *Cirrus acutus* the angularity of the body-whorl is quite lost in the upper ones, they becoming simply rounded. On the other hand, I think it more than probable that Prof. de Koninck is correct in regarding Phillips's *Cirrus pentagonalis* as only the young form of *C. acutus*. A much nearer relative of the latter than *E. pentangulatus* is *C. tabulatus*, Phillips, as pointed out by Prof. M'Coy, especially in the young state of the last named, although the whorls in *C. acutus* have not the depressed, truncated, and markedly rectangular appearance of *C. tabulatus*, which will at once separate the two. It is the

*Cirrus acutus*, J. Sow. Min. Conch. 1816, ii. p. 43, t. 141. fig. 1 (2 figs.).

*Cirrus acutus*, Phillips, loc. cit.

*Cirrus pentagonalis*, id. ibid. p. 226, t. 13. fig. 8.

- Euomphalus acutus*, De Koninck, Animaux Foss. p. 433, t. 24. fig. 7, a, b.  
*Straparollus acutus*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 537.  
*Euomphalus acutus*, &c., Morris, Cat. Brit. Foss. ed. 2, 1854, p. 247.  
*Cirrus tabulatus*, J. de C. Sow. Min. Conch. 1844, vii. p. 65, t. 638. fig. 2 (excl. figs. 3, 4).

8. *Cirrus tabulatus*, Phillips (p. 225, t. 13. fig. 7).

This figure is an improvement on the original, which is not quite so mathematically precise as the illustration represents it. It is, further, a small example of *C. tabulatus*, which at times grows to a very large size. Prof. M'Coy's remarks on this species are very much to the point; and he refers with great distinctness to the chief character, next to its tabulate whorls, viz. the truncation of the spire. I quite agree with M'Coy as to the resemblance borne by *C. tabulatus* to the variety of *Euomphalus pentangulatus* with the centre whorls somewhat elevated above, instead of depressed below, the marginal keel of the body-whorl. Under the name of *Euomphalus tabulatus*, Phill., Trautschold has figured\* a shell in no way agreeing with the true characters of the species. It is there represented as a planorbicular biconcave shell (at any rate more or less so), whereas in reality *E. tabulatus* has an elevated spire with large tabulate whorls.

There should be no mistaking this species after the figure of the fine specimen in the Gilbertson collection given by Mr. J. de C. Sowerby. *E. tabulatus* will, I believe, form the European type of Meek's subgenus *Omphalotrochus*. It is the

- Cirrus tabulatus*, Phillips, loc. cit.  
*Euomphalus tabulatus*, M'Coy, Synop. Carb. Limest. Foss. 1844, p. 38.  
*Straparollus tabulatus*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 541.  
*Cirrus tabulatus*, J. de C. Sow. Min. Conch. 1844, vii. p. 65, t. 638. fig. 1 (excl. figs. 2-4).

9. *Cirrus pentagonalis*, Phillips (p. 226, t. 14. fig. 8).

I have already expressed my concurrence with Prof. de Koninck in regarding this as probably the immature form of *C. acutus*. The figured specimen is easily to be recognized by the fracture above the mouth on the body-whorl.

10. *Cirrus rotundatus*, J. Sowerby (Phillips, p. 226, t. 13. fig. 15).

With the outward form of *C. acutus*, to a great extent, this species is distinguished, as originally pointed out by Mr. Sowerby, by having the upper part of each whorl rounded

\* Die Kalkbrüche von Mjatschkowa, 1874, pt. i. t. 4. fig. 12, a, b, c.

and not flattened. The spire varies in height, and the body-whorl in relative convexity. *C. rotundatus* of Sowerby has been universally regarded as a synonym of the *Straparollus Dionysii*, De Montf. On the other hand, Prof. M'Coy has to a great extent shown reasons for believing that a gradual passage may be traced between *S. Dionysii*, *Cirrus acutus*, Phill., and *Euomphalus anguis*, M'Coy; but Prof. Morris goes further and places the last-named species as a synonym of *Straparollus* or *Euomphalus Dionysii*, De Montf. The probability, I think, is, that they all three form varieties of an extended species, of which *S. Dionysii*, as the first described, may be taken as the type; it is a point, however, which can only be satisfactorily determined by the placing side by side of a large number of examples of each. It is the

*Straparollus Dionysii*, De Montfort, Conch. Syst. 1810, ii. p. 175, xlv<sup>e</sup> genre.

*Cirrus rotundatus*, J. Sow. Min. Conch. 1823, v. p. 36, t. 429. figs. 1, 2; Phillips, loc. cit.

*Euomphalus rotundatus*, M'Coy, Synop. Carb. Limest. Foss. 1844, p. 37.

*E. anguis*, M'Coy, tom. cit. p. 35, t. 3. fig. 11.

*E. Dionysii*, De Koninck, Animaux Foss. p. 438, t. 24. figs. 1-5, 8; Goldfuss, Petr. Germ. pt. 3, p. 88, t. 191. fig. 7, a-c.

*Straparollus Dionysii*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 539.

*Euomphalus Dionysii*, Morris, Cat. Brit. Foss. 1854, ed. 2, p. 247.

# 11. *Cirrus pileopsideus*, Phillips (p. 226, t. 13. fig. 6).

There are several examples of this shell in the Gilbertson collection; and it is in many ways a peculiar one: there is one which corresponds more nearly with the figure than any of the others. *C. pileopsideus* is discoid and much depressed, and has, indeed, a very different appearance from any of the other Carboniferous *Euomphali*. The whorls are, as described by M'Coy, somewhat imbricating; and the spire is more frequently than not depressed below the edge of the body-whorl. It is the

*Cirrus pileopsideus*, Phillips, loc. cit.

*Euomphalus clausus*, J. de C. Sow. Min. Conch. 1844, vii. p. 45, t. 633. fig. 1 (3 figs.).

*E. pileopsideus*, M'Coy, Synop. Carb. Foss. 1844, p. 37.

? *E. neglectus*, M'Coy, loc. cit. p. 36, t. 5. fig. 23.

*E. pileopsideus*, De Koninck, Animaux Foss. p. 437, t. 24. figs. 4, 6, a, b.

*Straparollus pileopsideus*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 540.

*Euomphalus pileopsideus*, Morris, Cat. Brit. Foss. 1854, ed. 2, p. 248.

# 12. *Cirrus spiralis*, Phillips (p. 226, t. 13. fig. 14).

I have not succeeded in finding a specimen which I could satisfactorily consider the figured example, unless it be one

with some matrix attached to it, not shown in the illustration.

This is a bluntly conical species, with a rather expanded base as compared with the height of the spire, the only break in the continuity of the cone being the slightly impressed sutures, there being no shoulder or upper flattened surface to each whorl as in many species of *Euomphalus*. It is a connecting link between *E. Dionysii* and *E. rotundatus*. The base is much flattened, becoming concave, with a by no means large umbilicus; spire short. The surface is ornamented with obliquely sigmoidal, crossed in some specimens by fine spiral lines. Very little appears to have been written concerning this species. It is the

*Cirrus spiralis*, Phillips, loc. cit.; Morris, Cat. Brit. Foss. 1843, p. 142; Broom, Index Pal. Nomen. 1848, p. 302; Brown, Foss. Conchol. 1849, p. 80, t. 41. fig. 18.

The name *Euomphalus spiralis* has been twice applied by Von Münster to shells described in the 'Beiträge'\*; but as one bears date 1840 and the other 1841, neither will clash with Phillips's species, which, whether we call it *Cirrus* or *Euomphalus*, has priority. It appears to me that the two shells so named by Von Münster on different occasions are specifically distinct.

*On the Species named Euomphalus and Cirrus by Phillips.*

The use of the names *Straparollus*, De Montf., *Euomphalus*, Sow., and *Cirrus*, Sow., has been made the subject of much confusion by conchologists and palæontologists. In the following remarks I shall endeavour to distribute the species described by Phillips, appertaining to one or other of these genera or subgenera, whichever term may be used, in their proper and respective sections. With this view it will be necessary to go over, to some extent, the early history of the names in question.

*Straparollus* was established by Denis de Montfort in 1810† for a cirroid shell from the Carboniferous Limestone of Namur, which, he remarked, possessed a large and smooth umbilicus, and an entire and inclined mouth: type *S. Dionysii*, De Montf.

*Euomphalus* was first introduced by James Sowerby in 1814‡ for an involute planorbicular shell with a depressed spire, and concave or largely umbilicate below, the mouth being "mostly angular:" type *E. pentangulatus*, Sow.

\* Beiträge zur Petrefactenkunde &c. Heft 3, 1840, p. 85, t. 15. fig. 8; ibid. Heft 4, 1841, p. 105, t. 11. fig. 2.

† Conchyl. Systém. ii. p. 175, xlvic genre. ‡ Min. Conch. i. p. 97.

The same author founded the genus *Cirrus* in 1816\*, and described it as a spiral conical univalve, without a columella, with the volutions united and funnel-shaped beneath; type *C. acutus*, Sow.

In 1837 Dr. Bronn† established the genus *Schizostoma* for certain of Sowerby's *Euomphali*, but with the mouth, as he supposed, sinuated and furnished with a band, as in *Pleurotomaria* and *Pleurotoma*: type *Euomphalus catillus*, Sow.

Prof. L. G. de Koninck‡ and Prof. F. M'Coy§, writing almost simultaneously, united the genera *Euomphalus* and *Cirrus* of Sowerby in one genus, under the name *Euomphalus*. The latter of these authors did so "knowing of no character by which to distinguish them; at the same time I am perfectly aware that *Euomphalus*, as it now stands, requires revision." Prof. de Koninck, on the other hand, went a step further than M'Coy, and referred the united *Euomphalus* and *Cirrus* to *Straparollus*, Montf.; however, to show the widely different outward form represented by such shells as *E. pentangulatus*, Sow., and *C. acutus*, Sow., or *S. Dionysii*, De Montf., he subdivided the combined genus into *Euomphali schizostomatoidei* and *E. cirroidei*.

In 1850 D'Orbigny|| united the three genera, adopting for the combination the name first given by Denis de Montfort, *Straparollus*.

The next important contribution to this subject is that by Prof. M'Coy, who, in the second fasciculus of his 'British Palæozoic Fossils', ¶, restricted the name *Euomphalus* to those forms with an entire peritreme, and often thickened, nearly entire circular lip, not indented by the preceding whorl: types *E. rugosus*, Sow., and *E. discors*, Sow. On the other hand, *Cirrus* is abandoned, and the name *Straparollus* used for both those cirroid and planorbicular shells in which the mouth is indented by the preceding whorl.

The last opinion I think necessary to refer to in this matter is that of Messrs. Meek and Worthen\*\*. These remarkably astute palæontologists point out that there is a discrepancy between the figures of *Straparollus Dionysii*, given by De Montfort and De Koninck, in the form of the mouth. On the general question they remark:—"We are aware Prof. M'Coy and some others regard *Euomphalus*, as typified by *E. pentangulatus*, as an exact synonym of *Straparollus*, and

\* Min. Conch. ii. p. 93.

† Lethæa Geogn. i. p. 95.

‡ Descr. Anim. Foss. p. 418.

§ Synop. Carb. Limest. Foss. 1844, p. 34.

|| Prodr. de Pal. i. p. 6.

¶ P. 297.

\*\* Illinois Survey Report, 1866, ii. p. 158.

that he proposes to transfer the former name to another group, consisting of rough *Cirrus*-like shells, of which *E. discors* and *E. rugosus*, Sowerby, are examples (see Brit. Pal. Foss. p. 279). It seems to us, however, that if the name *Euomphalus* is to be retained at all, we should apply it to the forms for which it was originally proposed, and that we have no right to transfer it to another type because Sowerby subsequently in another place refers this other type to his genus *Euomphalus*. If we regard *Straparollus*, Montfort, 1810, and *Euomphalus*, Sowerby, 1815, as exactly synonymous, then the latter name should be dropped from use, except in the synonymy of *Straparollus*, and could not, according to the most generally accepted rules of nomenclature, be transferred to the *E. discors* group, whether we view these shells as constituting a section of the genus *Straparollus*, or as an entirely distinct genus."

Now, notwithstanding the discrepancy in the figures of De Montfort and De Koninck, pointed out by the last-mentioned writers, I think, after investigating the matter thoroughly, there can be little doubt palæontologists have done wisely in uniting *Straparollus*, De Montf., with *Cirrus*, J. Sowerby, and that, in whatever form we look upon this combination in relation to those which follow, whether as a genus, subgenus, or section, the name adopted must certainly be *Straparollus*.

We next have to consider the name *Euomphalus*. By M'Coy the planorbicular shells for which Sowerby instituted the name were merged with the cirroid forms under the one name. Freely admitting that the total want of a columella and the existing large open umbilicus are points which of necessity place these shells in close generic contiguity, I still think that the very great discrepancy in form demands more than mere specific separation. In the present state of conchological science such a difference would be seized upon by workers amongst recent shells. It has been expressed by De Koninck in a sectional sense by using the terms *E. schizostomatoidei* and *E. cirroidei*, whilst Meek and Worthen have not hesitated to adopt *Euomphalus* in a subgeneric sense under *Straparollus* for the same purpose; in so doing I am quite in accord with them. Again, I quite agree with these writers in deprecating the use made of the term *Euomphalus* by Prof. M'Coy in his later work, viz. as a section for those *Euomphali* (typified by *E. discors* and *E. rugosus*) in which the peritreme is quite entire. The name *Euomphalus*, if retained, must, by all laws of nomenclature, be so (as they have pointed out) for those shells typified by *E. pentangulatus*. That Prof. M'Coy is right in retaining the shells in question separate from the *E.*



*pentangulatus* group I am convinced. I merely differ from him as to the nomenclature of this section, which, I think, requires a name for its recognition.

The classification of these *Euomphaloid* shells now advocated will be found expressed in the following table, which will also give the synonymy of each group, and the species which fall into it described by Phillips, with two exceptions.

The shells in question (*Cirrus tabulatus*, Phill., and *Euomphalus cristatus*, Phill.) require a separate notice. The first of these will, I have very little doubt, constitute itself a species of Meek's subgenus *Omphalotrochus*, the resemblance between his type (*O. Whitneyi*) and the fine example of *C. tabulatus* figured by Mr. J. de C. Sowerby being very great.

The second of these shells (*E. cristatus*, Phill.) has been made the subject of a distinct genus by Mr. J. de C. Sowerby, viz. *Phanerotinus*\*, which I propose to retain as such, following in this respect my friend Prof. J. Morris. It most certainly is not a *Euomphalus* simply.

#### Genus STRAPAROLLUS, De Montfort, 1810.

Section (a) *Straparollus* (proper), De Montf. 1810.

Type *S. Dionysii*, De Montf.

= *Cirrus*, J. Sow. 1814; *Euomphalus* (pars), Fleming, 1828; *Euomphalus*, M'Coy, 1844; *Euomphali cirroidei*, De Koninck, 1843; *idem*, Bronn, 1848; *Cirrus*, Brown, 1849; *Straparollus* (pars), D'Orbigny, 1850; *Straparollus* (pars), M'Coy, 1853; *Euomphalus* (pars), Eichwald, 1860; *Straparollus*, Meek and Worthen, 1866.

Species described by Phillips:—*Cirrus acutus*, J. Sow.; *C. pentagonalis*, Phill.; *C. rotundatus*, J. Sow. (= *S. Dionysii*, De Montf.); *C. pileopsideus*, Phill.; and *C. spiralis*, Phill.

Section (b) *Euomphalus*, J. Sowerby, 1814.

Type *E. pentangulatus*, J. Sow.

= *Bifrontia* (pars), Deshayes, 1824; *Schizostoma*, Bronn, 1837; *Schizostoma* et *Euomphalus*, Fischer, 1837; *Euomphalus* (pars), M'Coy, 1844; *E. schizostomatoidei*, De Koninck, 1843; *idem*, Bronn, 1848; *Straparollus* (pars), D'Orbigny, 1849 and 1850; ? *Discohelix*, Dunker, 1846; *Euomphalus*, Brown, 1849; *Straparollus*, M'Coy, 1853; *Euomphalus*, G. & F. Sandberger, 1850-56; *Euomphalus* (pars), Eichwald, 1860; *Euomphalus*, Meek and Worthen, 1866.

Species described by Phillips:—*Euomphalus pentangulatus*, Sow.; *E. catillus*, Martin; *E. calyx*, Phill.; *E. bifrons*, Phill. (= *E. pugilis*, Phill.).

\* Min. Conch. 1843, vii. p. 29.

## Section (c) (—), M'Coy, 1853.

Types: *E. rugosus*, Sow.; *E. discors*, Sow.

= *Straparollus* (pars), D'Orbigny, 1850; *Euomphalus* (pars), Eichwald, 1860; *E. discors* group, Meek and Worthen, 1866.

Species described by Phillips, none.

Section (d) *Omphalotrochus*, Meek.

Type *O. Whitneyi*, Meek.

= *Euomphalus* (pars), Phillips, 1836; *idem*, J. de C. Sowerby, 1844.

Species described by Phillips—*Cirrus tabulatus*, Phill.

## Genus PHANEROTINUS, J. de C. Sowerby, 1843.

Type *P. cristatus*, Phill.

=? *Ecculiomphalus*, Portlock, 1843; ? *Serpularia*, F. A. Römer, 1843.

Species described by Phillips—*Euomphalus cristatus*, Phill.

Various other generic names have at times been proposed for *Euomphalus*, or for sections of the genus, such as *Omalaxis*, Deshayes, *Bifrontia*, Deshayes\*; but as these are all posterior in date, or otherwise ineligible, I shall not now refer to them.

13. *Turbo tiara*, Sowerby (Phillips, p. 226, t. 13. fig. 9).

This is a fine example of the species, but much decorticated and not in a good state of preservation. The figure is a tolerably good representation. I have compared the Gilbertson specimen with that contained in the "Mineral Conchology Collection." It is the

*Turbo tiara*, Sow. Min. Conch. 1827, v. p. 97, t. 551. fig. 1 (2 figs.); Phillips, *loc. cit.*

*Platyschisma tiara*, M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 535; Morris, Cat. Brit. Foss. 1854, ed. 2, p. 269.

*Turbo tiara*, Brown, Foss. Conch. 1849, p. 73, t. 38. fig. 32; Bronn, Index Pal. Nomen. 1848, p. 1326.

14. *Turbo semisulcatus*, Phillips (p. 226, t. 23. fig. 10).

The type specimen of this so-called species is a beautifully preserved little shell; and the figure is good, except that some matrix remaining about the aperture is not represented. I quite agree with Prof. de Koninck in considering this only a variety of the next species, *Turbo biserialis*. The elongated

\* Descr. Coq. Foss. Env. Paris, ii. p. 221.

tubercles on the shell are open to much variability; we have specimens with only one row, some with two, and others with one row on one part of the surface and two on another portion of the same shell. The striæ of growth are strongly marked.

15. *Turbo biserialis*, Phillips (p. 226, t. 13. fig. 11).

There are several examples of this in the Gilbertson collection; and it is difficult to pick out the figured shell. The descriptions by Prof. de Koninck and M'Coy are clear and comprehensive. It is the

*Turbo biserialis* et *T. semisulcatus*, Phillips (as above).

*Littorina biserialis*, De Koninck, Animaux Foss. p. 458, t. 40. fig. 6.

*Turbo biserialis*, Bronn, Index Pal. Nomen. 1848, p. 1318; M'Coy, Brit. Pal. Foss. 1853, fasc. 3, p. 535.

*Turbo biserialis* et *T. semisulcatus*, Morris, Cat. Brit. Foss. 1854, ed. 2, pp. 282, 283.

*On the Shells called Turbo by Phillips.*

*Turbo tiara* has been placed by M'Coy in his genus *Platyschisma*, and has doubtless found an appropriate resting-place there. *T. biserialis* (= *T. semisulcatus*) is in want of a generic receptacle; and for it, in all probability, a name will have to be coined. By De Koninck it was placed in *Littorina*, and by M'Coy doubtfully in the genus under which it was described. By Meek and Worthen\* it has been regarded as forming a section of *Naticopsis*. We shall examine this subject further when we take up the species of that genus in the Gilbertson collection.

[To be continued.]

XLIV.—*New Cerambycidae from Ecuador.*

By CHARLES O. WATERHOUSE.

SINCE my last paper on Coleoptera from Ecuador I have determined three more species of Cerambycidae from among those collected by Mr. Buckley to be new, which I here describe.

In the Prionidæ, the specimens of *Prionacalus Buckleyi*, W., taken by Mr. Buckley differ immensely in size and development, in the same way as is seen in *P. cacticus* and *P. atys*; and the sculpture of the thorax varies also somewhat in all the species. I have seen one small example of *P. Buckleyi*

\* Illinois Geol. Survey Report, ii. p. 364.

which has the antennæ partly ferruginous ; but this, I think, is clearly not a specific character.

### Cerambycidae.

#### *Xestia polita*, n. sp.

Nigra, nitidissima ; thorace transversim rugulose, elytris sat crebre punctatis, ad apicem fere lævibus, quadrispinosis ; femoribus rufo-castaneis, apice nigris, tibiis tarsisque piceis.

Long. 12 lin.

Antennal tubercles obtuse, thickly punctured, as well as the front of the head. Antennæ as long as the elytra and half the thorax ; the basal joint strongly and thickly punctured. Thorax as long as broad, subcylindrical (scarcely at all arcuate at the sides), constricted at the extreme base and apex, in the usual way, with coarse close punctures at the sides ; the dorsal ridges rather regular and carried evenly across the disk, which is not impressed. Scutellum smooth and without pubescence. Elytra parallel, highly polished ; the punctuation is moderately close, at the base very distinct, but almost entirely wanting near the apex ; the extremely fine zigzag or vermiculate striation, usually apparent among the punctuation in the species of this genus, is almost entirely wanting, but can be traced near the base : each elytron has two short acute spines at the apex ; the outer one is scarcely longer than the sutural one. The abdomen is pitchy at the apex.

*Hab.* Sarayacu.

#### *Mallocera costifera*, n. sp.

Fusca, flavo-grisco tomentosa, opaca ; thorace tuberculis duobus discalibus nigris ; elytris fuscis, costis sex flavo-tomentosis, apice unispinoso ; femoribus quatuor posterioribus apice spinosis.

Long. 17 lin.

A rather broad flat species. Fuscous, clothed with yellowish pile. Head rather large and broad ; antennæ nearly twice as long as the whole insect, the joints without spines. Thorax as long as its width at the base ; with two small tubercles on the disk rather before the middle ; the sides with a slightly swollen cicatrice before the front angle, and with a conical tubercle rather behind the middle. Elytra fuscous, brownish towards the apex, not very much narrowed posteriorly ; each elytron with three obtuse costæ, one close to the suture, one near the side, the middle one not quite so long as the others ; the intervals gently concave, and rather thickly but obscurely punctured ; the apex of each elytron is obliquely truncate, the outer angle produced into an acute spine. Femora some-

what compressed, subparallel, the four posterior furnished at the apex with a strong spine.

*Hab.* Sarayacu.

CATORTHONTUS, n. gen.

Head deflexed in front almost at right angles with the forehead; the muzzle nearly as long as broad, parallel seen from the front; antennal tubercles a little elevated on the inner side like two ridges between the antennæ. Antennæ short; the second joint a little longer than broad, the third joint as long as the first and second together, the fourth scarcely more than half the length of the third, the following joints subequal. Eyes deeply emarginate above. Thorax a little broader than long, very convex and arched anteriorly, a little constricted at the base, and very deeply transversely impressed above the base. Elytra at the base a little broader than the thorax, and three times the length, meeting at the suture for more than half their length, beyond the middle rapidly acuminate, so that the apices are widely distant from each other. Anterior coxæ nearly globular, only very slightly conical, moderately raised above the prosternal process, which is very narrow and arched. The mesosternal process is moderately broad, slightly arched anteriorly. Metathoracic episterna very broad, straight on the inner side (*i. e.* parallel with the middle of the sternum), arcuately narrowed (from the outside) posteriorly. Abdomen not narrowed at the base. Femora pedunculate, much swollen at the apex.

This genus appears undoubtedly to belong to the Rhinotraginæ, but differs from all the genera of that subfamily in the form of the thorax, which recalls *Clytellus* (Tillomorphinæ), and in the form of the metathoracic episterna, which are narrowed from the outer margin, not from the inner.

I propose placing it before *Ommata*.

*Catorthontus collaris*, n. sp.

Flavus; capite thoraceque nigro lineatis; elytris fortiter punctatis, singulis ad basin nodo nitido, ante medium strigis binis fuscis, apice acuminato piceo, extus carinato.

Long. 6 lin.

Antennæ short, about the same length as the elytra, pitchy, darker in the middle, the apical joints gradually becoming a little more slender, the third and two or three following joints sparingly fringed above; each joint with a long stiff hair at its apex. Head with a stripe below each eye, two stripes in front, the inner angle of the antennal tubercle, a stripe across behind the eyes, and the back part of the head

above, black. The cheeks behind the eyes are considerably swollen. Thorax a very little broader than the head, very convex and arched in front, depressed and transversely impressed at the base, where it is also a little constricted; with a black band in front, quadridentate posteriorly, and with a second narrower curved band behind the middle, bidentate behind in the middle, touching the lateral projection of the anterior band and nearly uniting with it at the apex; the anterior band is thickly and very strongly punctured. Elytra one fifth broader than the thorax, flat on the back, perpendicularly deflexed at the sides of the shoulders, thickly and strongly punctured; each elytron has a raised oblong-ovate spot in the middle of the base, with a brown streak under the shoulder and two oblique dusky streaks before the middle, the second one turned backwards at an acute angle on the side; the apex is very acuminate, pitchy, with a strong ridge along the outer margin, continued anteriorly by an oblique paler yellow line. There is a black band across the metasternum; and the episterna are bordered in front and behind with black. There is a spot at the side of the basal segment of the abdomen, a complete band across the second and third segments, and a spot in the middle of the posterior femora, all black.

*Hab.* Sarayacu.

*Allæsia bicolor*, n. sp.

Nigra, capite thoraceque rufis, antennis flavis ad apicem fuscis; elytris cyaneis æneo tinctis, creberrime sat fortiter punctatis. Long.  $6\frac{1}{2}$ –9 lin.

Resembles *A. chlorophana* in form and appearance. The raised parts of the thorax are smooth, the impressed portions are strongly punctured; at the base there is a triangular purple spot. Scutellum black. Elytra rather strongly and very densely punctured; blue or blue tinted with green. The first five or six joints of the antennæ are yellow, the apical joints fuscous. The form of the thorax is that of the variety *nitidipennis*, Chevr., having a small obtuse tubercle at the side.

*Hab.* Chiguinda.

XLV.—*Description of two new Humming-birds from Bolivia.*  
By JOHN GOULD, F.R.S.

MR. CLARENCE BUCKLEY, who has distinguished himself by his zoological researches in South America, passed, as is well

known, some considerable time in Bolivia some few years ago. On his return to this country I became the fortunate possessor of many of his specimens of Humming-birds; but, owing to the illness which has afflicted me for a considerable time, I have not been able, till lately, to incorporate Mr. Buckley's specimens in my collection of Trochilidæ. Having now been able to examine my series more closely, I have come to the conclusion that two species, at least, are new to science, and I place a description of these two birds at once before the public. One is a new *Cyanthus*; but the other is a new form so different that it must be generically separated.

*Cyanthus bolivianus*, sp. n.

Similar to *C. mocoa* from Ecuador, but much smaller and of a brighter metallic green, and with the tail more of a brilliant steel-blue than a vivid green. Total length 6·3 inches, culmen 0·7, wing 2·6, tail 4·1, tarsus 0·2.

*Hab.* Bolivia.

I possess several males of this new species, as well as of the allied *C. mocoa*; so that it is not without ample material before me that I describe the Bolivian bird as new to science. *C. mocoa* measures 8 inches in length, and has a wing of 3 inches and a tail of 5·5 inches.

PINAROLÆMA\*, gen. nov.

The general appearance of this bird reminds one of *Lampornis*; but it has an extremely long wing. In the latter respect it resembles *Oreotrochilus*; but it differs from this genus in its strongly curved and lengthened bill and in its very broad tail-feathers, while its extremely small feet seem peculiar to the genus.

*Pinarolæma Buckleyi*, sp. n.

Brown, with a purplish gloss on the back; the upper tail-coverts and tail-feathers brown, glossed with purple, and having a subterminal band of steel-blue; under surface of body brown, slightly washed with metallic green; the throat lighter brown, the feathers edged with paler brown, giving a scaly appearance; vent and under tail-coverts white, the latter washed with brown. Total length 4·6 inches, culmen 1·05, wing 2·95, tail 1·85, tarsus 0·15.

*Hab.* Misqui, Bolivia, 10,000 feet.

\* *πινάρως*, sordidus; *λαιμός*, guttur.

XLVI.—*New Neotropical Curculionidæ*.—Part II.

By FRANCIS P. PASCOE, F.L.S. &amp;c.

THE species described in this part, and the subfamilies to which they belong, are:—

## HYLOBIINÆ.

*Pileophorus procerus*.

## CRYPTORHYNCHINÆ.

*Bothrobathys anticus*.

*Epitasis*, n. g.

—— *niveosparsa*.

*Nettarhinus granulatus*.

—— *rudis*.

*Thrasyomus*, n. g.

—— *tumens*.

—— *angulatus*.

## ZYGOPINÆ.

*Copturus conjunctus*.

—— *expletus*.

—— *bisellatus*.

—— *lyra*.

—— *paroticus*.

—— *musculus*.

—— *crux*.

—— *collaris*.

—— *eximius*.

*Pileophorus procerus*.

*P. angustus*, parallelus, squamositate brunnea, obscure pallidiora varia, tectus; elytris singulatim apice late emarginatis. Long. 4 lin.

*Hab.* Cayenne.

Narrow and elongate, the sides nearly parallel, but the prothorax a little broader than the elytra, covered with a dark brown squamosity mixed with a paler brown approaching to dull yellowish, especially a median line on the prothorax and along the elytral suture; rostrum shorter than the head; eyes lateral and widely apart; antennæ very short, the club large; prothorax granulate, the apex extending beyond the head; scutellum punctiform; elytra slightly narrower at the apex than at the base, coarsely and closely seriate-punctate, posteriorly declivous and tuberculate, the apex of each elytron ending in two small tubercle-like processes, between which is a well-marked curvature; legs and body beneath with a dense pale brown squamosity.

The type of this singular genus, *P. nictitans*, a very rare insect, is compared by Lacordaire to an *Apate*; the above differs in its longer and narrower form and in the absence of the white band on the elytra.

*Bothrobathys anticus*.

*B. sat* late ovatus, dense squamosus, prothorace transverso, apice tubulato et bifasciculato-squamoso, lateraliter gradatim angustiore; elytris breviusculis, lateribus rotundatis. Long. 2 lin.

*Hab.* Parana.



Rather broadly ovate, closely covered with scales of a dark brown colour, but paler on the sides of the prothorax and middle of the elytra; head with four fascicles of erect dark brown scales, among which are a few white; rostrum dark brown, without scales, except at the base; antennæ ferruginous; prothorax nearly twice as broad as long, tubular in front, two fascicles of dark brown scales at the apex, behind the tubular portion the disk of the prothorax rises abruptly into a transverse ridge marked more or less with paler erect scales, sides gradually narrowing to the base; scutellum not apparent; elytra short, somewhat cordiform, seriate-punctate, tuberculate, two compressed tubercles on each side, crowned with erect scales; legs varied with brown and whitish projecting scales; third and fourth joints of the abdomen very short.

#### EPITASIS.

*Rostrum* modice arcuatum, capite sesquilingius, apicem versus latius, basi semialatum; scrobes medianæ. *Antennæ* mediocres; articulo primo funiculi validiore; clava distincta. *Prothorax* transversus, ad latera rotundatus. *Scutellum* distinctum. *Elytra* subovata, prothorace paulo latiora. *Rima* pectoralis mesosterno terminata. *Abdomen* segmentis intermediis æqualibus; sutura prima arcuata. *Femora* mutica; *tibiæ* rectæ; *tarsi* modice elongati; *ungues* approximati.

The affinity of this genus is not obvious; but it is certainly to be placed among the numerous forms which are classed with *Tragopus*, *Acalles*, *Tylodes*, and their allies. Its essential character lies in the form of the rostrum, which is expanded, although but slightly, at the base, its junction with the head being marked by a notch or incision on each side.

#### *Epitasis niveosparsa*.

*E. ovalis*, squamulis fusco-silaceis tecta, aliis niveis setulisque fuscis erectis adspersa; antennis flavidis. Long.  $1\frac{1}{3}$  lin.

*Hab.* Brazil.

Oval, closely covered with yellowish-brown scales, others of a snow-white colour forming conspicuous spots on the prothorax and elytra, and long, erect, dark brown scales (those arising among the white spots also white) intermixed; rostrum with a raised line at the base; antennæ yellowish ferruginous; prothorax rather short, bisinuate at the base, a few white scales in the centre; scutellum round, black, scaleless; elytra rather convex punctate-striate, but the punctures nearly concealed by the scales, the apex broadly rounded; legs covered with more or less projecting scales.

*Nettarhinus granulatus.*

*N. subcylindricus*, silaceo-squamosus, granulis numerosis nigris nitidis adpersus; scapo modice elongato; elytris apice acutis. Long.  $4\frac{1}{2}$  lin.

*Hab.* Venezuela.

Subcylindrical, covered with brownish-yellow scales, the upper surface studded with numerous black shining granules; head and rostrum black, the former with scattered scales, a few extending to the base of the latter, its lower half unequally punctured; antennæ pale ferruginous, the club darker, scape rather long, slender; prothorax about equal in length and breadth, much constricted anteriorly, towards the base two elevated somewhat pointed tubercles; scutellum indistinct; elytra rather short, broader than the prothorax, pointed at the apex, granules arranged in rows, the intervals closely covered with scales; body beneath and legs with paler scales, the last three abdominal segments darker.

A short thick-set form like *N. bilobus* (Ol.), but differs in coloration and sculpture.

*Nettarhinus rudis.*

*N. subcylindricus*, piceus, squamulis parvis silaceis adpersus; scapo breviusculo; elytris apice rotundatis. Long. 4 lin.

*Hab.* Brazil.

Subcylindrical, pitchy, with small scattered brownish-yellow scales; head and rostrum black, coarsely punctured, except the latter, towards the apex; antennæ ferruginous, the club darker, scape rather short; prothorax rather broader than long, the sides well rounded, constricted anteriorly, closely and strongly punctured, the base with three tubercles; scutellum elongate; elytra coarsely punctured, the intervals granulate, each granule bearing a short, thick, erect scale, the apex rounded; body beneath and legs pitchy; tibiæ short and much compressed.

This species differs *inter alia* from its congeners in the rounded apex of the elytra.

## THRASYOMUS.

*Rostrum* modice elongatum; scrobes medianæ, rectæ. *Antennæ* graciles; funiculi articulis duobus basalibus æqualibus; clava breviter ovata, distincta. *Prothorax* transversus, lobis ocularibus nullis. *Elytra* breviuscula, convexa, prothorace multo latiora, regione scutellari depressa. *Rima* pectoralis metasterno terminata, apice aperta. *Pedes* robusti; *femora* valida, infra dentata; *tibiæ* unguiculatæ. *Abdomen* segmentis tribus intermediis æqualibus.

The pectoral canal extending to the metasternum or beyond is the character of a small group of Cryptorhynchinæ forming Lacordaire's "sous-tribu Sophrorhinides." In this new genus the absence of ocular lobes and the short broad elytra differentiate it from *Mecistocerus*; in *Metrania*, another genus without ocular lobes, the pectoral canal is prolonged to the basal segment of the abdomen. The sides of the elytra bounding the scutellum, sloping inwards or depressed, will, I think, often afford a valuable generic character.

*Thrasyomus tumens.*

*T. niger*, subnitidus, setulis griseis adpersus; rostro basi carinato; elytris rude punctatis ad latera haud ampliatis. Long  $5\frac{1}{2}$  lin.

*Hab.* Chontales.

Black, somewhat glossy, with scattered grey setulose scales, more crowded in the punctures; rostrum smooth, pitchy, an elevated line at the base; head and prothorax granulate-punctate, the latter transverse, much narrower anteriorly, a smooth elevated line in the middle; scutellum oblong, pointed behind; elytra somewhat triangular, very convex, shoulders prominent, apex rounded, striate-punctate, the interstices scarcely raised, punctures coarse and quadrate; body beneath sparingly punctured, each abdominal segment having only a single row; tibiæ fluted, the inner edge straight; tarsi rather short, equal, the third joint broadly bilobed.

*Thrasyomus angulatus.*

*T. niger*, setulis griseis adpersus, lateribus prothoracis condensatis; rostro haud carinato; elytris subgranulato-punctatis, ad latera subito deflexis. Long.  $4\frac{1}{3}$  lin.

*Hab.* Nauta.

Dull black, with scattered greyish scales, which are more numerous on the sides of the prothorax; rostrum smooth, pitchy, without an elevated line at the base; antennæ ferruginous; prothorax as in the preceding, but less granulate, and the elevated line confined to the apex; scutellum shortly oval; elytra trigonate, the sides abruptly deflexed and marked off from the back by a sharply-defined angle, seriate-punctate, the punctures coarse and bounded behind on each side by a small glossy granule; body beneath irregularly punctured; legs as in the preceding species.

This species is at once distinguished by the sharply angular or carinated sides of the elytra and their peculiar sculpture. Both species have a slightly marked ridge on the front between the eyes.

*Copturus conjunctus*.

*C. oblongus*, subangustatus, niger, elytris brunneo-fuscis; rostro tenui; antennis ferrugineis, funiculo articulo secundo longissimo; prothorace oblongo, basi gibboso; elytris supra depressis, apice suturali mucronato. Long. 4 lin.

*Hab.* Cayenne.

Oblong, rather narrow; rostrum slender, black; antennæ ferruginous, second joint of the funicle as long as the next five together; prothorax about equal in length and breadth, gibbous behind, black, with two faint yellowish lines at the side; scutellum rounded; elytra depressed above, a little rounded anteriorly at the sides, and abruptly rounded at the apex, the suture terminating in a short spine, contiguous to its fellow, chocolate-brown, the middle with an obscure round black spot with a narrow whitish line behind, punctate-striate, the interstices flattish; body beneath black, scaleless, except that the first abdominal segment and a triangular spot on the second are closely covered with minute ochreous scales; femora strongly toothed beneath and bidentate at the apex, black, the posterior with the basal two thirds ochreous; pectoral canal confined to the propectus.

*Copturus* illustrates the difficulty of defining a large genus. Every character is liable to exception, not one appearing to have a generic value, although there is a common interresemblance which is not to be mistaken; the group, in fact, is a natural one, but which perhaps might, for the advantage of the systematist, be artificially divided into several genera.

Among the few species with mucronate elytra this may be known by the mucro being confined to the sutural edge, so that, when the elytra are closed, it appears only as one.

*Copturus expletus*.

*C. subrhomboidalis*, niger, prothorace lineis tribus, elytris in medio squamis ochraceis ornatis; rostro modice elongato, piceo-fusco; antennis fulvis, funiculi articulo secundo quam primum sesquilongiore; elytris rude striato-punctatis. Long.  $3\frac{2}{3}$  lin.

\* *Hab.* Pará.

Somewhat rhomboidal, black, varied with ochraceous; rostrum moderately long, pitchy brown; antennæ fulvous, second joint of the funicle half as long again as the first, the third and fourth equal and as long as the first; prothorax transverse, the sides gradually narrower towards the apex, black, strongly punctured, three lines on the disk of yellowish scales; scutellum oblong; elytra flat above, strongly punctate-striate, the punctures in the striæ large and nearly confluent, a broad stripe of ochraceous scales along the suture, but confined to

the interstices, the striæ between with a row of snowy-white scales; body beneath closely covered with cretaceous scales; legs with the scales setulose and less approximate; femora sharply toothed beneath, the posterior scarcely attaining the end of the elytra; last joint of the tarsi and claws black; pectoral canal extending between the anterior coxæ, not limited behind.

The flat disk of the elytra and the relative length of the joints of the antennæ appear to be good differential characters.

*Copturus bisellatus*.

*C. rhomboidalis*, niger, squamulis ochraceis maculatim ornatus; prothorace transverso, antice haud constricto, postice scutellum versus producto; scutello conspicuo; elytris subcordatis, fortiter sulcato-punctatis. Long. 4 lin.

*Hab.* S. Paulo.

Rhomboidal, black varied with spots and patches of ochreous scales; rostrum black; antennæ ferruginous; prothorax transverse, closely punctured, the sides with a broad ochreous stripe, which descends on the sides of the pro- and mesothorax, enclosing a large black scaleless space; scutellum conspicuous, rounded; elytra subcordate, punctate-striate, punctures coarse, the raised interstices smooth, scaleless; a large ochreous spot behind the scutellum, and a smaller one behind, both lying in and dividing a broad black sutural stripe, an ochreous spot also midway at the side; body beneath with close-set greyish scales, the four posterior abdominal segments with a common large black patch; legs with grey setulose scales; femora toothed beneath.

The large enclosed patch on the side of the pro- and mesothorax seems diagnostic of this species.

*Copturus lyra*.

*C. rhomboidalis*, niger, squamulis ochraceis inæqualiter et maculatim vestitus; prothorace transverso, postice producto, scutellum tegente; elytris subcordatis, pone scutellum figura X-formi maculisque quatuor ochraceis ornatis. Long. 3 lin.

*Hab.* Brazil.

Rhomboidal, black, with more or less scattered ochreous scales, but collected in spots on the elytra; rostrum rather short, black; eyes comparatively small; antennæ yellowish, second joint of the funicle as long as the three next together; club short, rounded; prothorax transverse, constricted at the apex, acutely produced posteriorly and hiding the scutellum; elytra subcordate, broadly rounded at the apex, an X-shaped spot at the base, one on each side at the middle, and two at

the apex, pale ochreous and distinctly limited; femora slightly toothed beneath, the posterior extending about a third of their length behind the elytra; posterior half of the first and the whole of the second abdominal segment closely covered with ivory-white scales.

The scutellum, if present, covered by the scutellar process of the prothorax is a remarkable character, so far as I have noticed, confined to this species. In this and the preceding species the pectoral canal extends to the intermediate coxæ, and the posterior femora pass beyond the end of the elytra.

*Copturus paroticus.*

*C. subrhomboidalis*, niger, squamulis ochraceis maculatim varius; rostro brevisusculo, apicem versus ferrugineo; antennis fulvis, funiculi articulo secundo quam primum dimidio longiore; clytris punctato-striatis, interstitiis crenatis. Long.  $1\frac{1}{2}$  lin.

*Hab.* Parana.

Subrhomboidal, black, nearly scaleless above; rostrum comparatively short and stout, ferruginous towards the tip; antennæ fulvous, second joint of the funicle half as long again as the first; prothorax transverse, a large oblique patch of ochraceous scales curving upwards on each side; scutellum punctiform; elytra subcordate, broadly rounded at the apex, punctate-striate, the punctures separated by glossy spaces, the interstices crenate, a small ochraceous spot in the centre, another close to the apex, and one or two nearly obsolete at the side; body beneath with scattered greyish setulose scales; femora toothed beneath, the posterior not extending to the end of the elytra; tarsi ferruginous; pectoral canal extending to the intermediate coxæ.

Allied to *C. vestitus*, Boh., but more rhomboidal and differently coloured.

*Copturus musculus.*

*C. ovatus*, fuscus, squamulis setiformibus ochraceis sparse vestitus; rostro brevisusculo, nigro, apice antennisque fulvis; funiculo articulis duobus basalibus longitudine subæqualibus; femoribus haud dentatis. Long.  $1\frac{1}{2}$  lin.

*Hab.* Parana.

Ovate, dark brown, sparsely covered with ochraceous setulose scales; rostrum comparatively short and stout, black, the tip fulvous; antennæ fulvous, scape short, first joint of the funicle stout, second about the same length, the rest gradually shorter; prothorax transverse, a nearly scaleless space on each side the median line; elytra rather short, callous at the shoulders, the apices rounded, punctate-striate, interstices

flattish, scales more crowded posteriorly; body beneath with subapproximate ochraceous scales; femora not toothed beneath, the posterior not extending to the end of the elytra; pectoral canal extending to the intermediate coxæ.

In size and shape this species resembles *C. confinis*, Boh.; but, *inter alia*, the femora are edentate.

*Copturus crux.*

*C. ovatus*, niger, elytris postice litera T signatis; antennis modice elongatis, funiculi articulis duobus basalibus fere æqualibus; femoribus obsolete dentatis. Long.  $1\frac{2}{3}$  lin.

*Hab.* Parana.

Ovate, black, the elytra at the apex with a snowy-white T-shaped mark; rostrum comparatively short, ferruginous; antennæ moderately long, fulvous, the first two joints of the funicle nearly equal; prothorax transverse, slightly rounded at the base, very coarsely punctured, a raised longitudinal line in the middle; scutellum oblong or subtriangular; elytra rather short, their apices rounded, coarsely striate, the striæ apparent, impunctate, the interstices crenate; body beneath closely covered with white scales; femora short, obsoletely toothed; tibiæ and tarsi ferruginous.

This species in outline and mutic femora resembles the preceding, but is larger and differently coloured.

*Copturus collaris.*

*C. rhomboidalis*, niger, maculatim albido-squamulosus; rostro tenuato, piceo-nigro; funiculi articulo secundo quam primum quadruplo longiore; prothorace apice late rufo-fasciato; elytris tenuiter striatis. Long.  $2\frac{1}{2}$  lin.

*Hab.* Ega.

Rhomboidal, black, varied with yellowish-white spots; rostrum slender, pitchy black; antennæ fulvous, second joint of the funicle four times as long as the first; prothorax transverse, rather finely and closely punctured, a broad band of pure red scales at the anterior border, and at the base three small yellowish spots; scutellum rounded; elytra subcordate, callous at the shoulders, finely striate, the striæ apparently impunctate, the interstices flattish and minutely punctured, three distinct yellowish spots on the suture, the basal largest, and two on the disk at the side; body beneath covered with approximate white scales; femora sharply toothed beneath; pectoral canal not extending beyond the anterior coxæ, but the rostrum impinging on the metathorax.

Allied to *C. rubricollis*, Boh., but rhomboidal in outline, differently sculptured, and spots otherwise modified.

*Copturus eximius.*

*C. ovatus*, ater, prothorace supra (medio excepto) elytrisque plaga magna tripartita coccineis; femoribus infra bidentatis, posticis valde elongatis. Long. 3 lin.

*Hab.* Columbia.

Ovate, jet-black, with bright scarlet patches on the prothorax and elytra; rostrum elongate, slender, broader towards the tip, glossy brown; antennæ fulvous, scape short, funicle long, the second joint twice as long as the first; prothorax transverse, rounded at the base, a black spot in the middle, and the sides black, the rest covered with scarlet scales; scutellum black; elytra rather shorter, broadly rounded at the apex, punctate-striate, a broad scarlet band rather behind the middle and continued anteriorly along the suture to the base; sides of the sterna, second and third abdominal segments closely covered with yellow scales; femora slender, sinuate beneath, and in the sinus two teeth, the proximal by far the largest; posterior femora very long, their tibiæ at the apex, and tarsi, except the last joint, ochraceous, claws fulvous; pectoral canal extending to the intermediate coxæ.

This beautiful species is remarkable for its long posterior femora, which extend for more than half their length beyond the elytra. The pectoral canal extends to the anterior border of the metasternum.

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MISCELLANEOUS.

*On the Origin and Development of the Ovum in Encope before Fecundation.* By M. C. MEREJKOWSKY.

THE ovaries of the Medusa, arranged in the interior of the bell, have the appearance of four little sacs, produced by an evagination of the gastrovascular cavity. In the walls of the ovaries, from without inwards, we find a layer of ectodermic cells, the limits of which are not well defined, and the entoderm composed of several layers of better-defined cells. The innermost layer of the entoderm, that which covers the inner surface of the ovary, is composed of the same cells (furnished with a vibratile cilium) as the entoderm of the radial canals.

Towards the base of the ovary, where it becomes confounded with the lower surface of the bell, the entodermic layer is as yet only formed of a single stratum, as in the radial canal; but in proportion as we advance towards the interior of the ovary, we see the entodermic cells divide in a direction perpendicular to their length, and thus form two superposed layers of entoderm; the



division of the cells continuing in all directions, we thus find the entoderm grow thicker and thicker.

Between these two lamellæ of entoderm and ectoderm forming the ovary, there is a third, more delicate lamella destitute of structure; this is the *intermediate lamella*, which separates them in a very marked manner, and assists to define with certainty which layer produces the ova of the *Encope*; these ova always occurring *beneath* the intermediate lamella, and being thus separated by that lamella from the ectoderm, can only be developed from the entoderm. But another reason leads us to accept the entodermic origin of the ova of the *Encope*, if we observe directly all the graduated transitions between the ordinary entodermic cells and the young ova. The changes in an entodermic cell destined to be developed into an ovum, which I must now notice, consist in the increase of the volume of this cell and the transformation of the nucleus into a germinal spot.

In the entodermic cells lining the radial canals, the protoplasm is perfectly transparent and destitute of granules; the nucleus appears in the form of a clear round spot, containing at the centre a round nucleolus of greater density. Subsequently we observe that the cells, as well as their nuclei and nucleoli, increase in size, and the protoplasm becomes more and more granular. The nucleolus, which is at first simple and furnished with a small vacuole, begins to divide. As I have described in the case of a Medusa of the White Sea\*, at the commencement of the division the nucleolus elongates, becomes constricted in the middle, makes a bend which gives it the form of a horse-shoe, and finally divides into two parts, each of which possesses a central vacuole; then each half divides again (simultaneously or not) into two parts, but in a direction perpendicular to the first (as in the segmentation of the ovum), and so on.

Although these phenomena are constant and normal in the Medusæ of the White Sea, I have only observed them exceptionally in the Medusæ of the Gulf of Naples. Usually in the latter the division of the nucleus takes place in a perfectly different manner, which has not yet been described. When, after it has become elongated, the nucleolus presents a median constriction, it does not divide into two parts, but simply becomes elongated in the form of a band twisted upon itself; constrictions then forming at various parts of it, the nucleolus, from being originally round, becomes a long moniliform ribbon rolled up in several turns. Each division of the chaplet is fusiform and round; it regularly contains in the middle a very small vacuole, and is united to the neighbouring divisions by a thin and sometimes rather long articulation. Sometimes this long sinuous band, which reminds us of the nucleus of certain Infusoria (*Stentor*, *Spirostomum*), splits into two bands. Finally the grains or articulations of the chaplet separate, and,

\* "Studies on Hydroids," Ann. & Mag. Nat. Hist. ser. 5, vol. i. p. 254, pl. xiii. figs. 9-14 (1878).

instead of a nucleolus, there is formed at the centre of the nucleus a whole group of several dozens of small round balls, which collect into a sphere placed at some distance from the walls of the nucleus. Afterwards these balls continue to divide for some time, thus becoming more and more minute at the same time that their number reaches several hundred. During all the time that these phenomena are being produced the ovum enlarges and attains its definitive diameter, which is nearly twenty times that of the entodermic cells which gave origin to the ovum.

The definitive aspect of the perfectly mature ovum before fecundation is that of a sphere of granular protoplasm with a central and perfectly *uniform* nucleus, showing not the smallest trace of any nucleolus whatever. The hundreds of granules into which the nucleolus has been divided have become dissolved in the protoplasm of the nucleus.

*Summary.*—1. The ova of *Encope* are developed from entodermic cells.

2. The nucleolus acquires the form of a chaplet twisted upon itself; the grains of the chaplet become isolated and continue to divide.

3. The mature ovum before fecundation has no longer the least trace of a nucleolus in its nucleus, which is entirely homogeneous. —*Comptes Rendus*, April 26, 1880, p. 1012.

#### *Observations on the Megapodes.* By M. E. OUSTALET.

A commission given to me by the École des Hautes Études having enabled me to visit the great museums of England and Holland, I have been able to complete the investigations that I had undertaken upon the Gallinaceous birds of the family Megapodiidæ, and I have ascertained that the number of species admitted by modern ornithologists is too large, and may be reduced to about twenty-five.

By a comparative study of skeletons of Talegallas, Maléos (*Megacephalon*), Megapodes, Guans (*Penelope*), and Guinea-fowl, I have also ascertained that the creation of a separate group, proposed by Prof. Huxley\*, that of the Peristeropodes, including the two families Cracidæ and Megapodiidæ, was fully justified; but that the Pintados present certain analogies of structure with these birds which that learned zoologist has not, perhaps, sufficiently brought out.

On dissecting a Talegalla I met with certain arrangements indicated by Dr. Garrod in the Maléo; but, on the other hand, I remarked that other peculiarities in the mode of insertion of the muscles of the wing and leg were not of so much zoological importance as that anatomist thought it right to ascribe to them.

Again, on examining a collection recently sent by M. Bruijn I found that *Talegallus jobiensis* also occurs on the continent of New Guinea, and that *T. pyrrhopygius*, when adult, possesses a wattle on the front of the neck, and that it always has the nostrils rounded

\* "On the Alectoromorphæ," in *Proc. Zool. Soc.* 1868.

and the bill and feet much stronger than in *T. Cuvieri*. Analogous characters, but still more strongly marked, may be observed in a new species from the island of Waigiou, a species which I shall propose to call *Talegallus Bruijnii*. This *Talegalla* from Waigiou not only bears a wattle on the front of the throat, but it has on the middle of the head a regular crest which is continued posteriorly by a sort of hood with two pendants. It deserves to be classed, with *T. pyrrhopygus*, in a new subdivision of the genus *Talegallus*, the subgenus *Æpypodius*\*.

Recent discoveries have compelled me partially to rectify the frontiers assigned to the Peristeropodes by Prof. Huxley, and have proved that the northern limit of these birds only coincides at one point, near Lombok, with Wallace's line. Considered generally, the area of habitat of the Peristeropodes forms on the surface of the globe a band extending between 20° of north latitude and 40° of south latitude, but cut up in the direction of the meridians by two enormous gaps. The Hoccoes and the Penelopes occupy a considerable portion of this band, namely that which corresponds to tropical America; while the Megapodes and their allies are spread over islands which seem for the most part to be the fragments of an old southern continent. This hypothesis is supported by the fact that the Megapodes cease suddenly towards the east in the region where the atolls commence. To the west the Megapodes are still more widely separated from the Cracidæ; but it is important to remark that in this direction the African continent is inhabited by the Pintados or Numididæ, the affinities of which to the Megapodes are greater than is generally supposed.

Thus the geographical distribution of the Megapodiidæ seems to be perfectly in agreement with their zoological relationships; but when we study the habitat of each genus, or, still better, of each species, we recognize many anomalies which it is often difficult to explain in a satisfactory manner. To cite only one example, we are astonished to find on the Nicobars a Megapode allied to those of New Guinea, whilst we find no analogous form in Java, or in Sumatra, or in Malacca. I do not think, as Mr. Wallace does, that this species has been imported by the Malays, but rather believe that it has remained, along with *Calœnas nicobarica*, as the evidence of a fauna that has disappeared. Every thing, in fact, concurs to prove that the Megapodiidæ represent an extremely ancient type among the Gallinacæ. In their mode of reproduction they seem to have retained some characters of the reptiles, since they lay eggs of extraordinary size, the incubation of which they often abandon to the action of the sun's rays.

Lastly, it may perhaps be well to recall the fact that up to the present day there has not been discovered in the Tertiary strata of these countries the smallest fragment that can be referred to a

\* From *ἀνίς*, elevated, and *πόδιον*, support, foot. I should certainly have preferred the name *Æpypus* to *Æpypodius*, if the latter had not the advantage of reminding us by its termination of the word *Megapodius*.

Peristeropode, still less to a Talegalla or a Megapode. From this negative result we may, I will not say assert, but at least suppose that at that distant epoch this remarkable type of Gallinaceæ was already foreign to Europe, and was confined to the Indo-Australian region.—*Comptes Rendus*, April 19, 1880, p. 906.

*On the Structure of some Coralliaria.* By M. C. MEREJKOWSKY.

Among the Coralliaria, the Actiniæ especially have been the best investigated. The almost total deficiency of facts relating to the microscopic structure of the other groups decided me to undertake a special study of some species common in the Bay of Naples, such as *Astroïdes* &c. The following are the results at which I have arrived.

The ectoderm, examined by means of sections and of maceration, proved to be composed of the following elements:—

1. Ordinary ectodermic cells of very elongated form, strongly depressed and dilated at the superior extremity, which is constantly furnished only with a single cilium. In this respect the ectodermic cells of *Astroïdes* are very notably distinguished from those of the Actiniæ described by M. Heider, which have always several very short cilia.

2. The preceding cells, but with this difference, that they become transformed at their base into an excessively long and delicate filament, sometimes furnished with several inflations, which our knowledge of the group of the Cœlenterata authorizes me to call *nervous filaments*.

3. Epithelio-muscular elements composed of cells no. 1 (more normal, that is to say shorter and broader) united at their base to muscular fibrillæ. This kind of element is not, however, so frequently met with here as in the endoderm; at their apex there is always a long cilium.

4. Nematocysts of two kinds: larger ones, often surrounded by protoplasm, with a nucleus and a long filament (nervous) in the posterior part; the others smaller, of a different form, and always provided with a long posterior filament; the filament here and there bears small nodosities.

5. The last elements of the ectoderm are the glandular cells, always pyriform and with coarsely granular contents.

*Mesoderm.*—The elastic and structureless membrane which separates the ectoderm from the entoderm varies in thickness in the different parts of the body; it forms longitudinal protuberances upon the faces of two mesembryonthal septa which unite at the surface of the stomach. The muscles which line this elastic membrane in a single layer are longitudinal in the interior of the animal, and arranged in horizontal circles at the exterior. They are either long slightly flattened filaments, the relations of which to the other histological elements it is not easy to ascertain, or they are fibrillæ forming a part of the epithelio-muscular elements.

We must also mention another very curious element, consisting of cells of comparatively large size and exceedingly flattened, much

ramified, united to each other by their ramifications, and filled with granular contents, with nucleus and nucleolus. They are arranged in a layer, and rest immediately upon the outer surface of the elastic membrane. In some cases I have been able to convince myself that their ramifications, which, beyond all doubt, are nervous, are continued into strongly refractive fibrillæ. Their form, their whole habit, their position beneath a layer of ectoderm rich in cells furnished with long filaments directed towards the elastic membrane, and, lastly, the fibrillæ in which their ramifications sometimes terminate, leave no room to doubt that they are nervous ganglia in which the numerous fibrillæ of the different ectodermic cells terminate. This supposition is rendered the more probable by analogous facts observed in the *Actiniæ* and the *Medusæ*.

*Entoderm.*—The entoderm is almost exclusively composed of very typical epithelio-muscular cells. The epithelial cell is not so strongly elongated as in the ectoderm; it is broader and shorter, with the base much dilated, and furnished at the extremity with a single cilium. The muscular fibril is very refractive, fusiform, nearly three times as long as the cell itself. Besides these elements we also find glandular cells not differing essentially from those already described. These unicellular glands are met with in great numbers, especially upon the parts of mesembryenthal partitions nearest the stomach, as well as on the mesembryenthal filaments.

Besides *Astroïdes*, I may cite *Sagartia parasitica* and *Medusa æquorea* as having shown me epithelio-muscular elements in very great numbers in the entoderm. As to the presence of a single cilium at the extremity of the ectodermic cells, this is not a character peculiar to *Astroïdes*, but appears to be very common in the *Coralliaria*; I have ascertained its occurrence, for example, in *Paralecyonium elegans*, *Isis*, *Caryophyllia*, *Anthea cereus*, and *Sagartia parasitica*.

*Mesembryenthal filaments.*—The surface of the stomach is not smooth, but covered with longitudinal elevations, each of which corresponds to the place where a partition is united with the stomach. These protuberances are very rich in glandular cells, and it is only in them that the stomach presents such cells. At the extremity of the stomach the protuberances form the free edges of the mesembryenthal partitions; there is therefore an uninterrupted continuity of these longitudinal protuberances at the surface of the stomach with the mesembryenthal filaments; and this fact explains the complete unity in the structure of these two organs, and enables us to assert that they can only act as stomach, that is to say, as organ of digestion. The filaments are solid and have no cavity in the interior; they have in the centre a mesodermic trunk formed by elastic membrane, which unites with that of the partitions. I have been able to demonstrate the absence of any canal passing through the partitions and uniting the chambers formed by them.

The organs of generation and the development of this coral will constitute the subject of an early communication.—*Comptes Rendus*, May 3, 1880, p. 1086.

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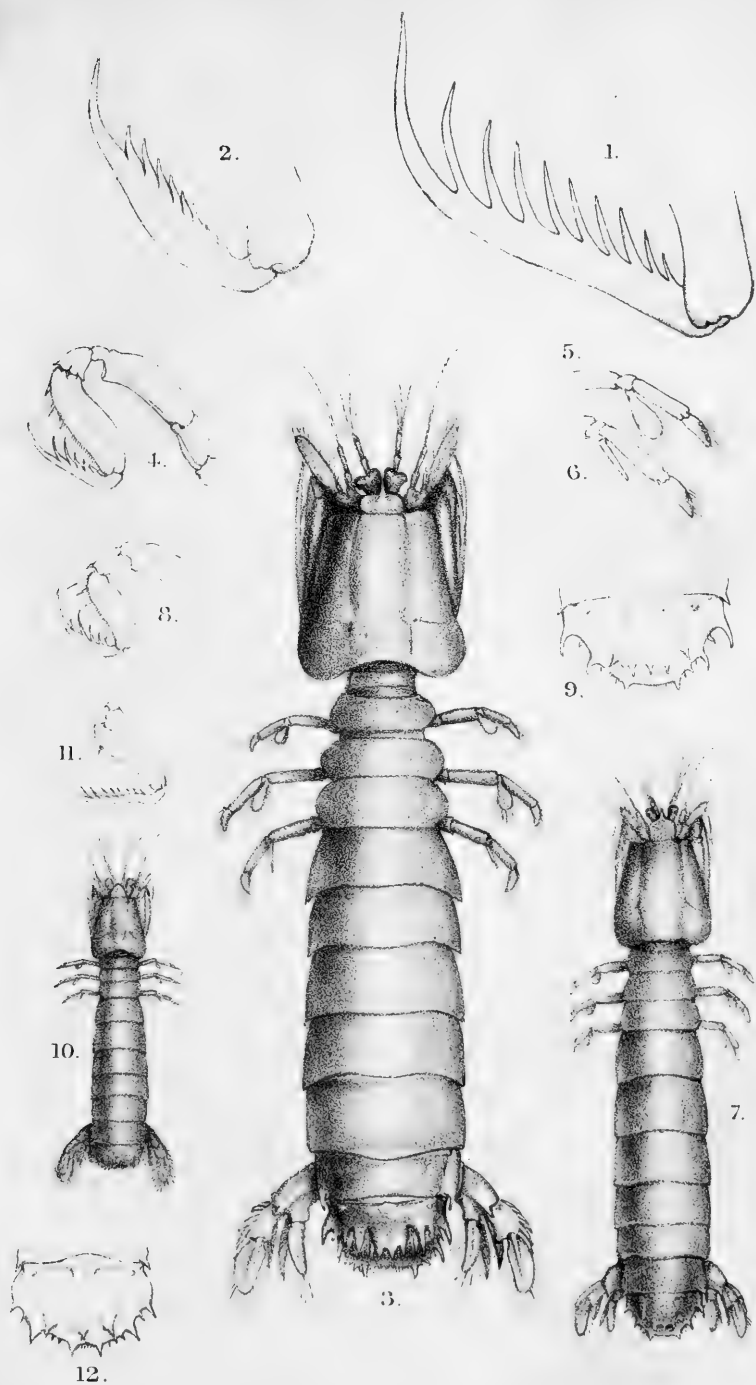
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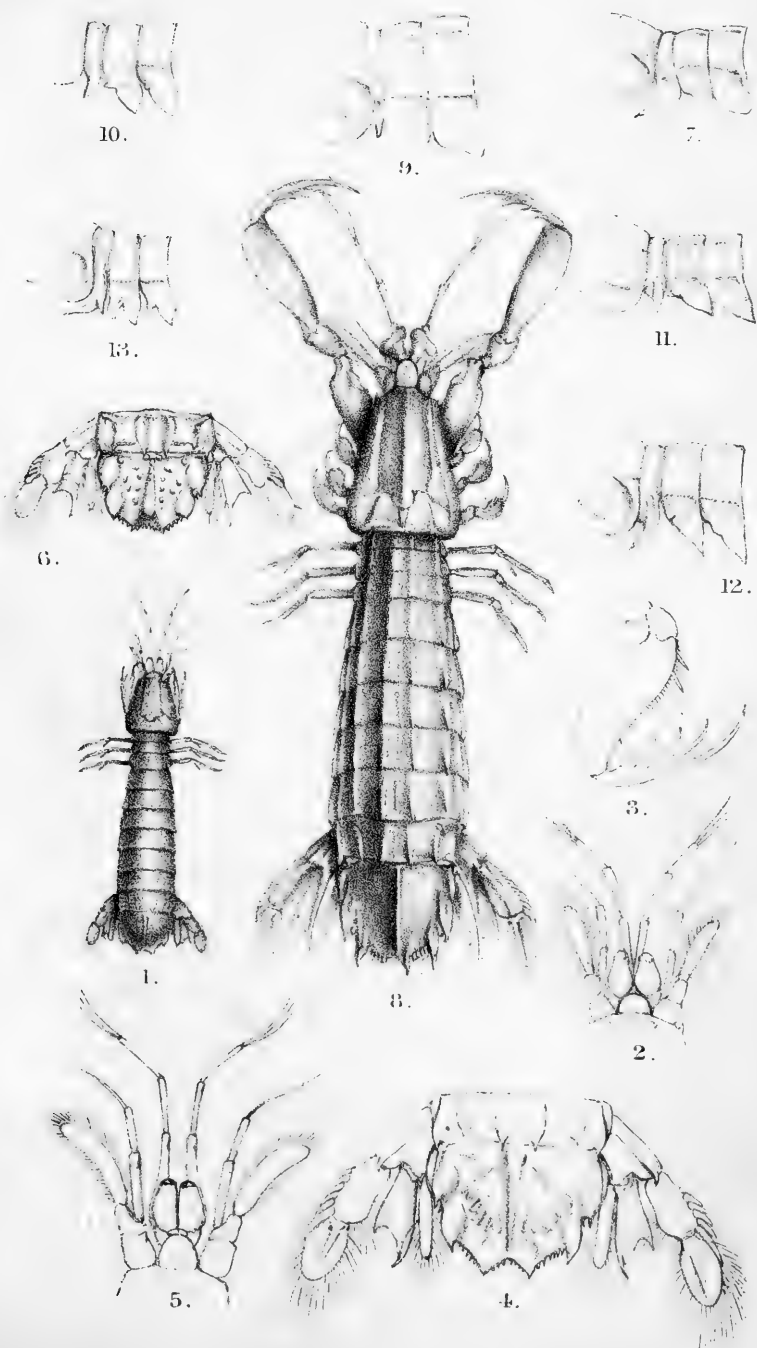
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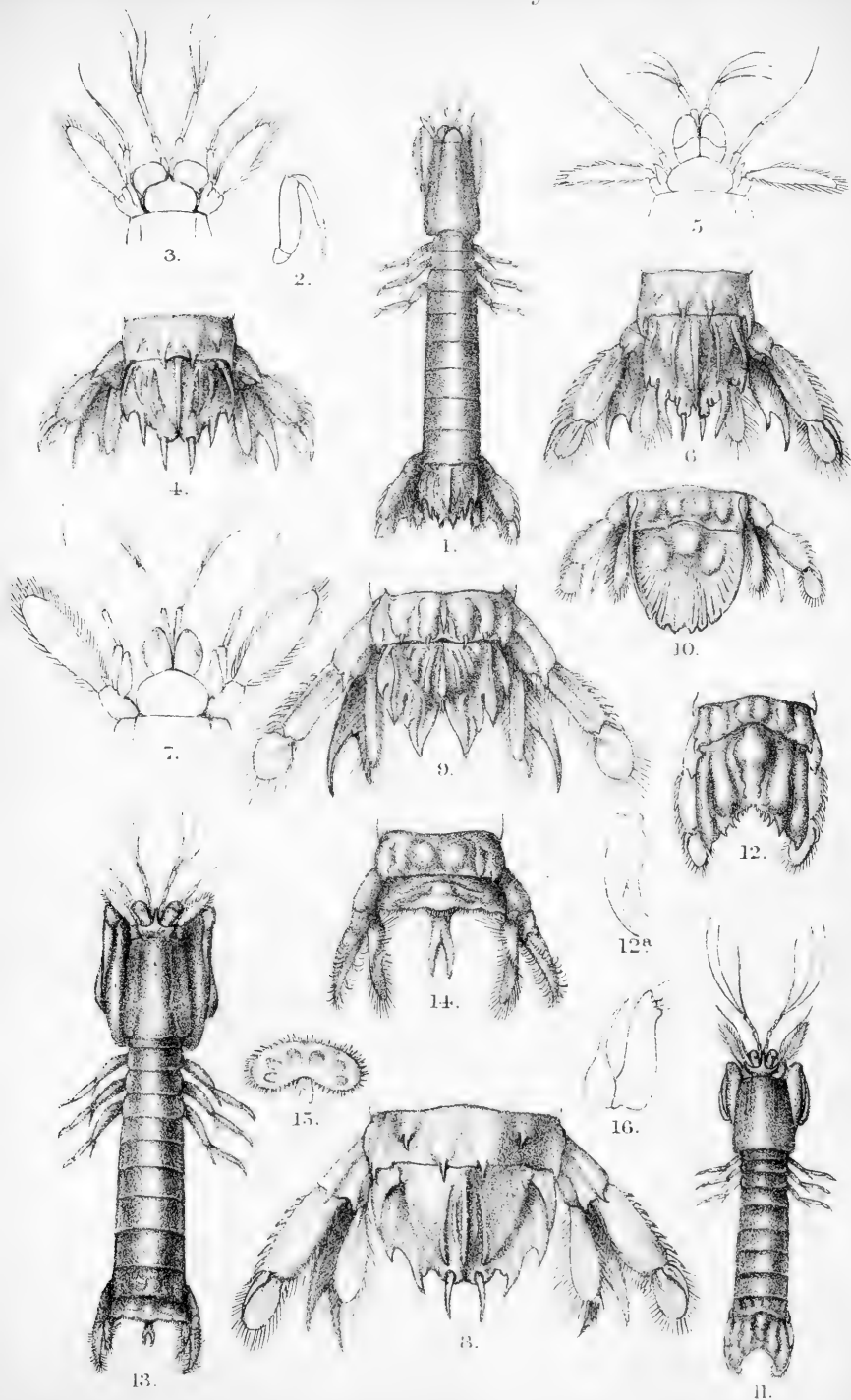
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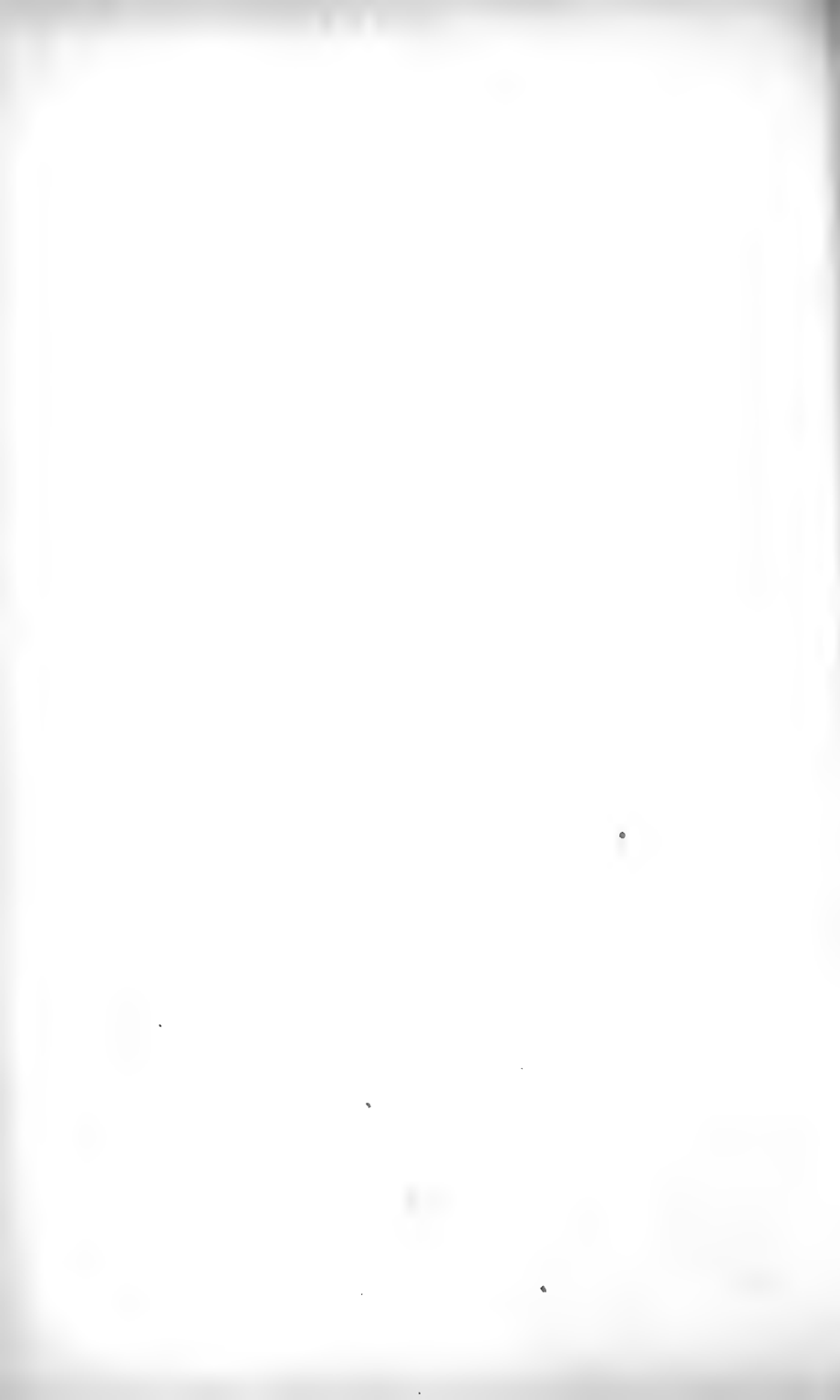




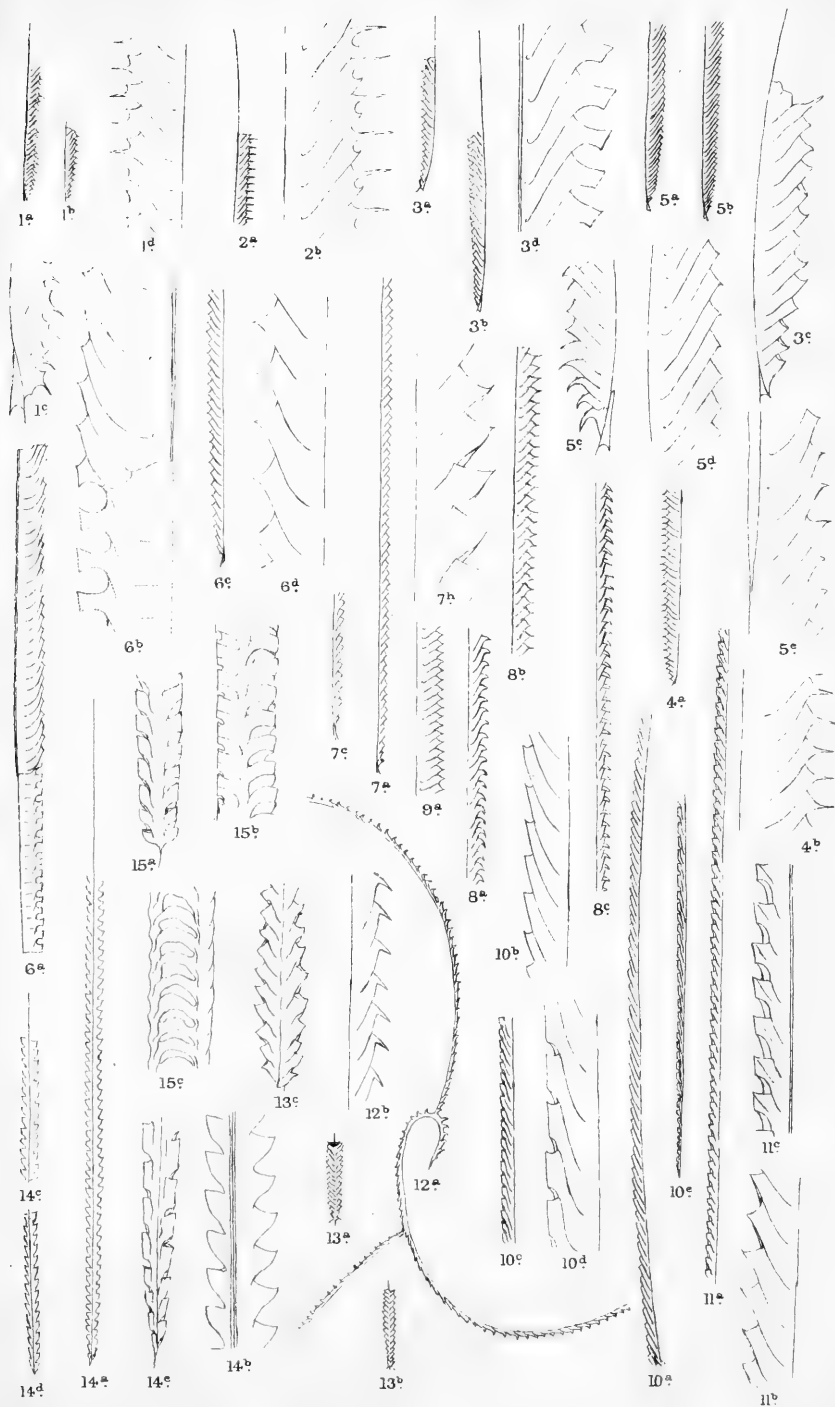




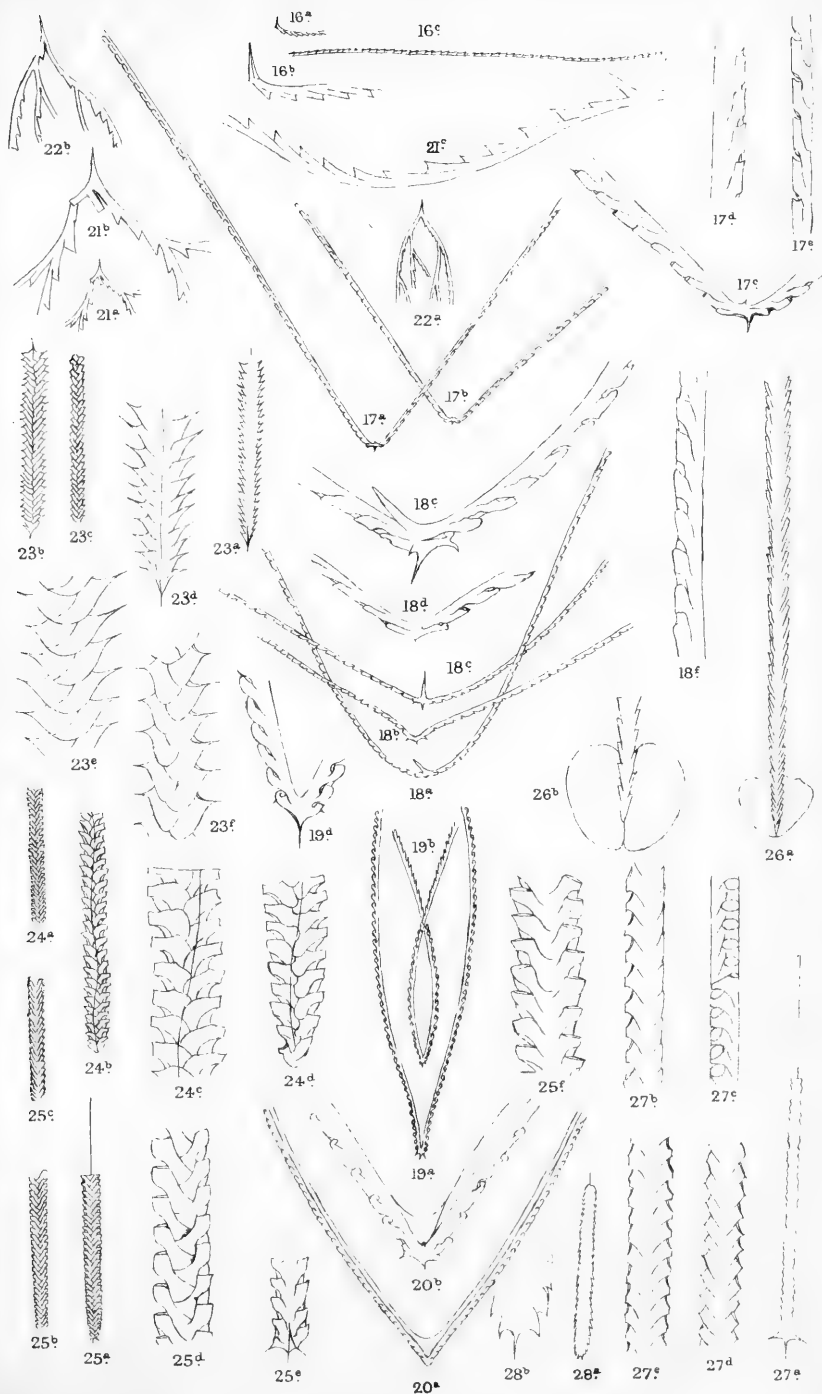




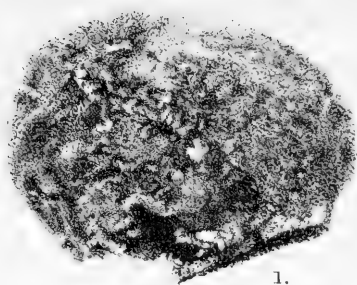




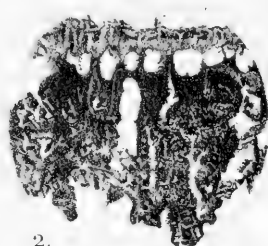




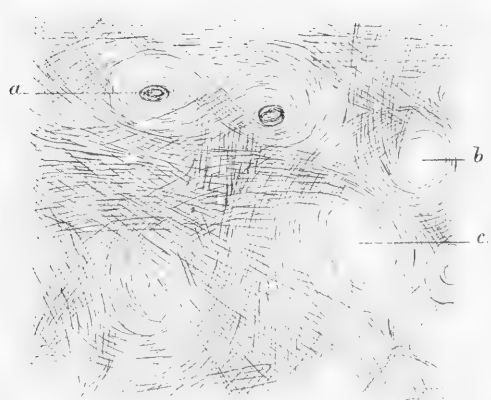




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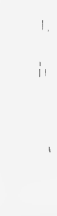
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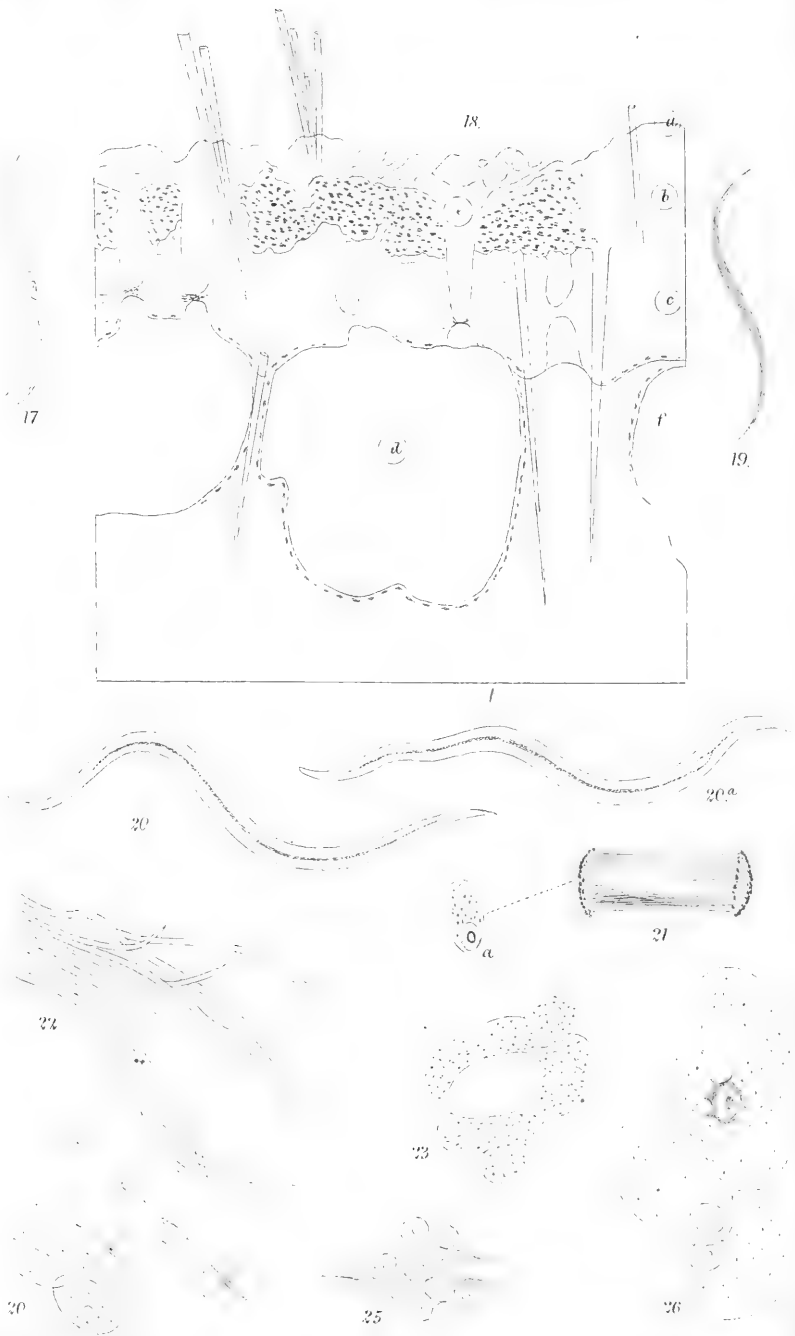


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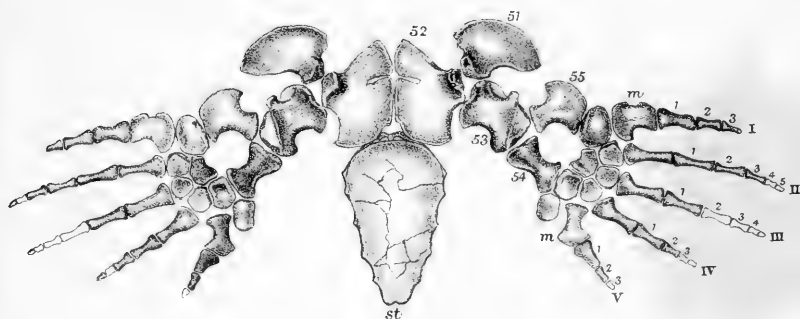


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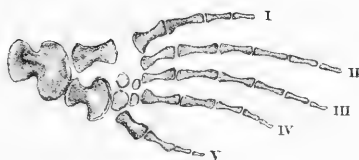


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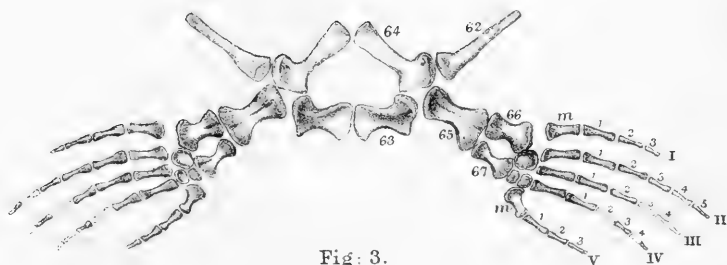


Fig: 3.



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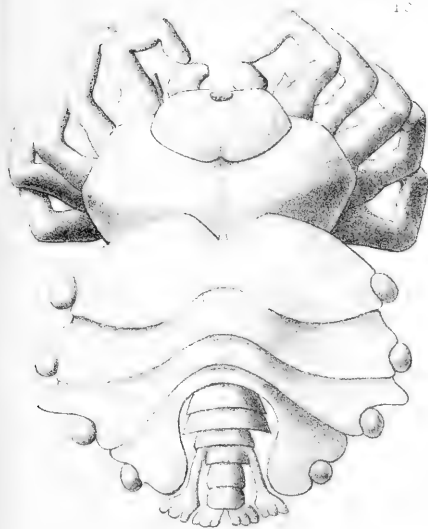


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Fig. 3.

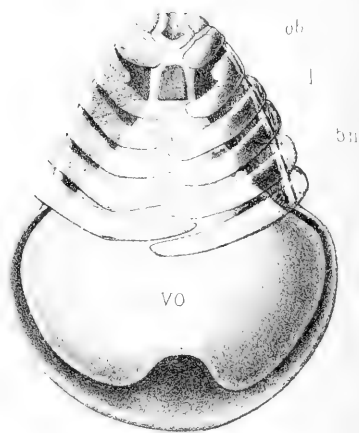


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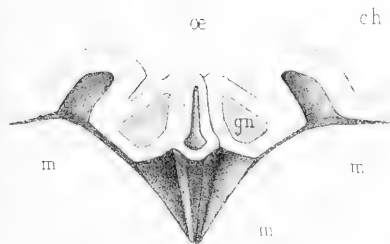
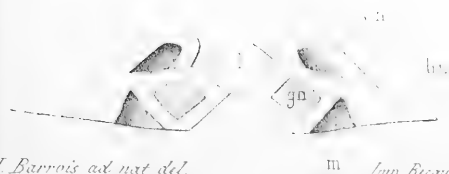


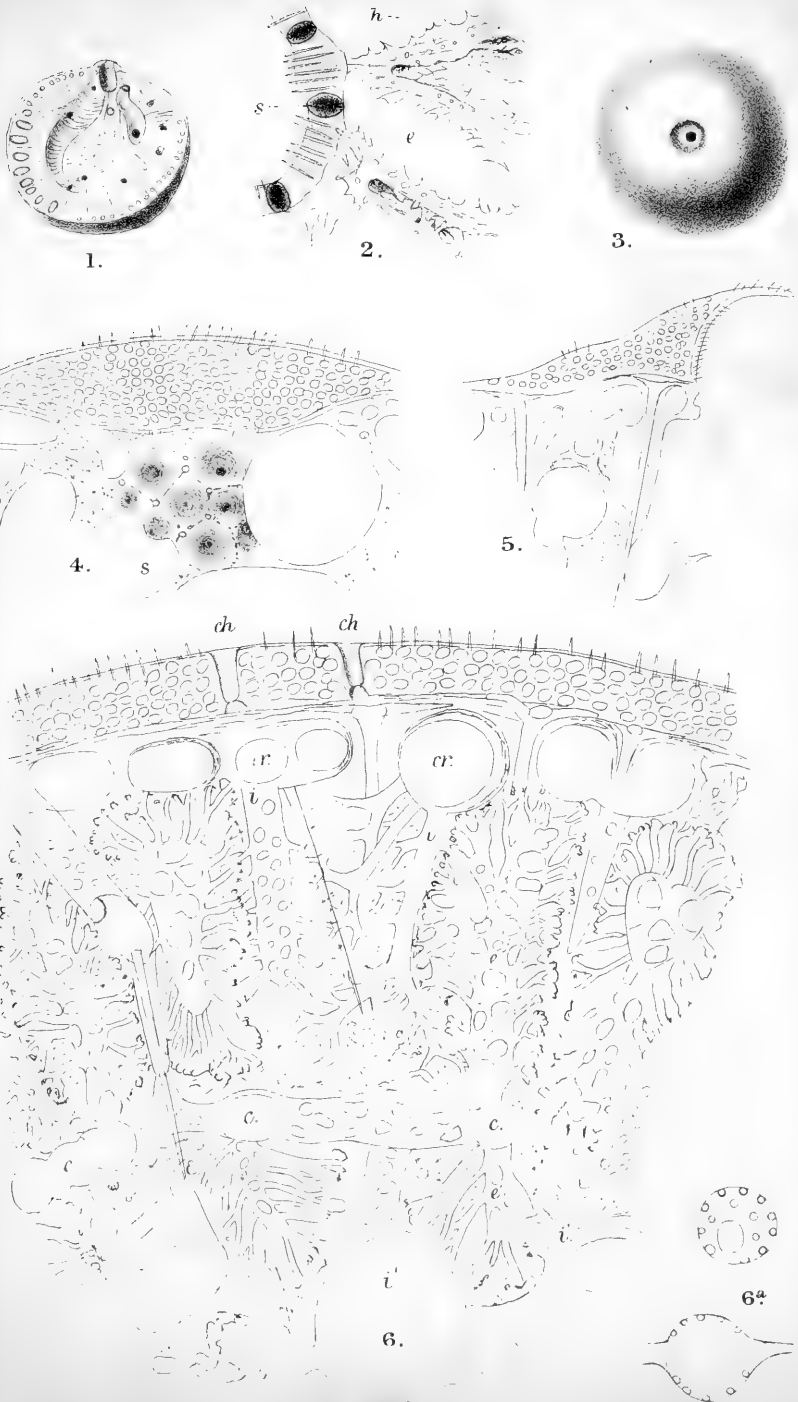
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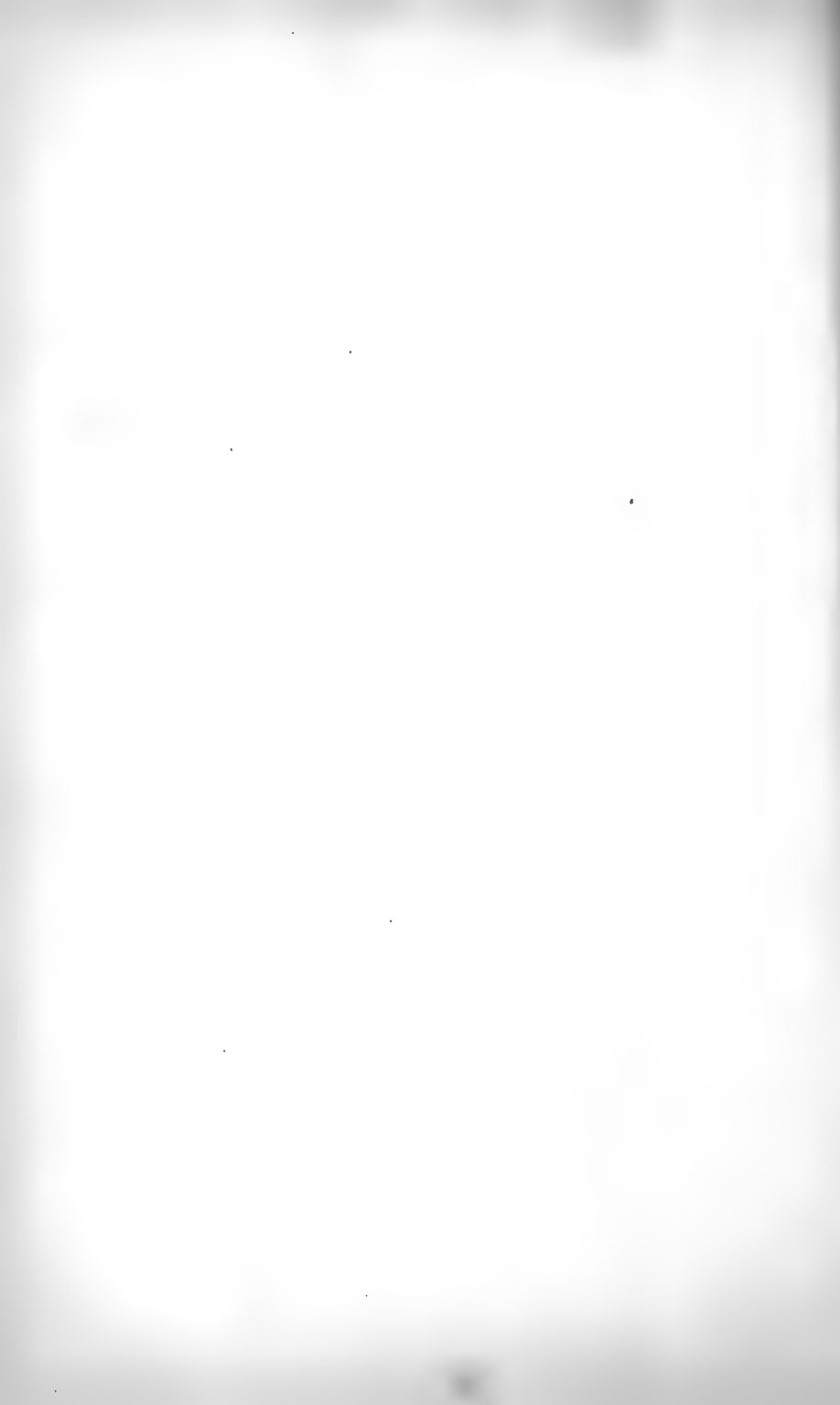


Fig. 6.











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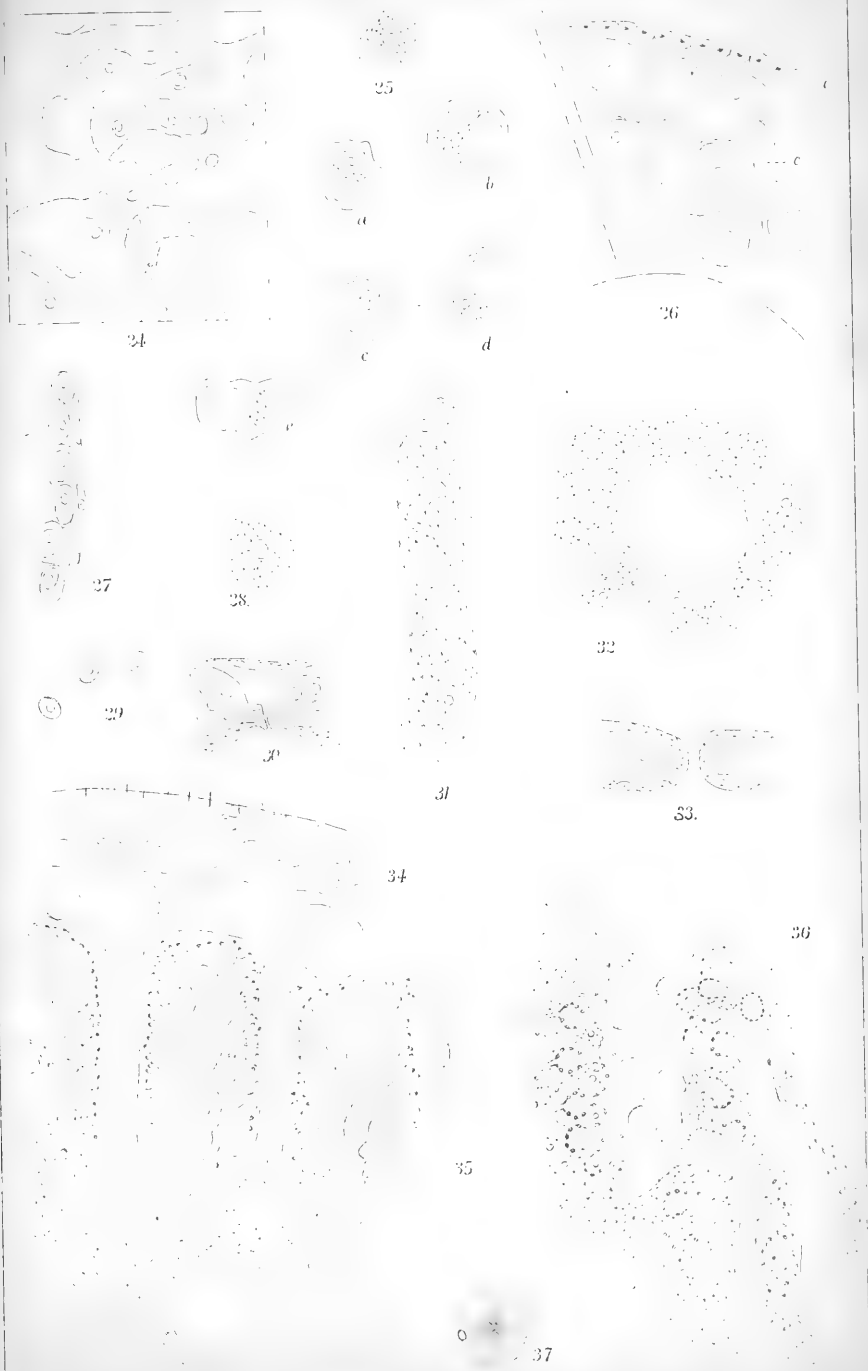
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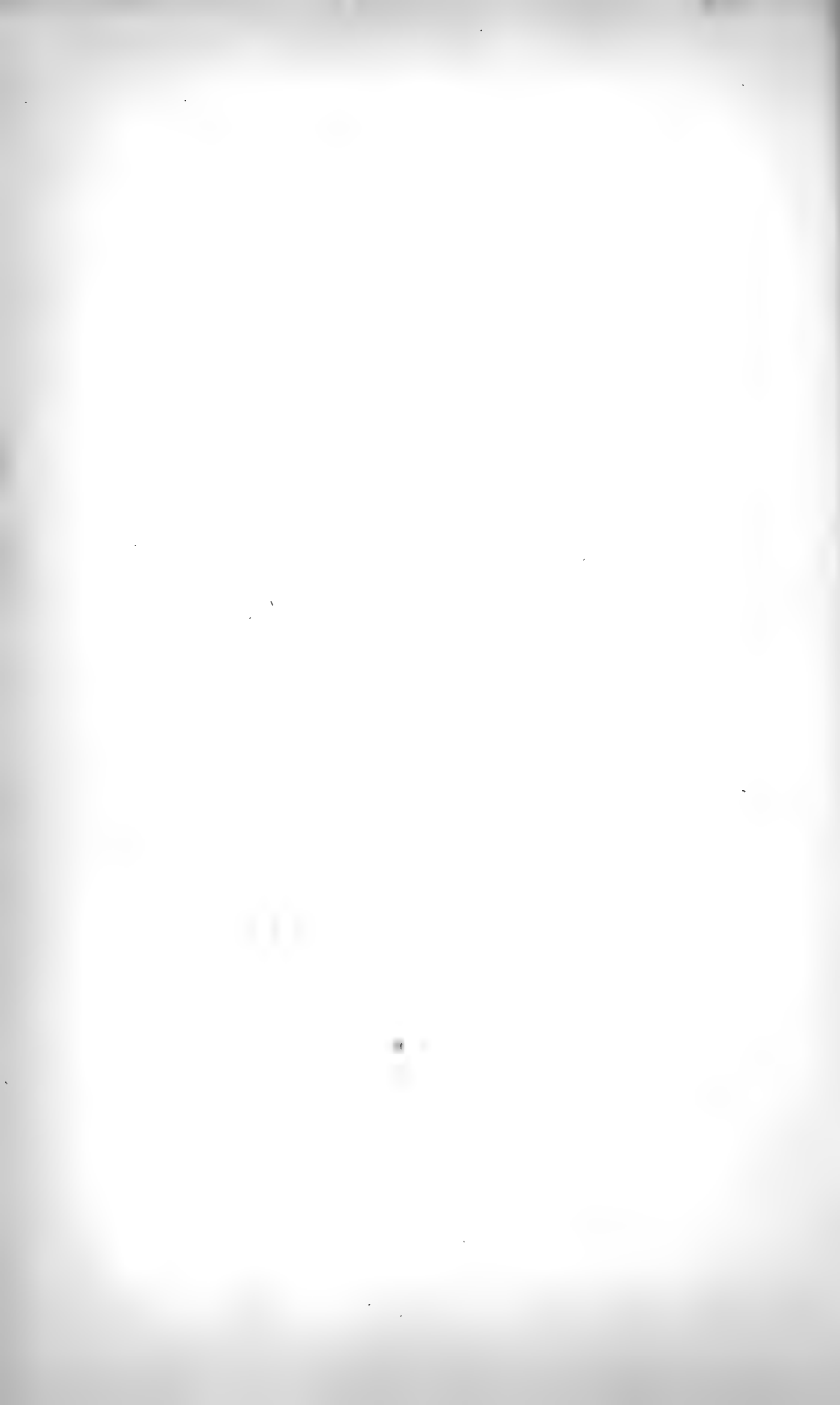
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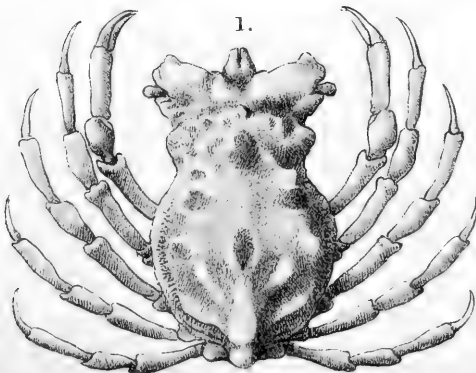
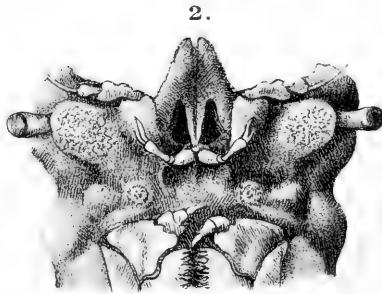
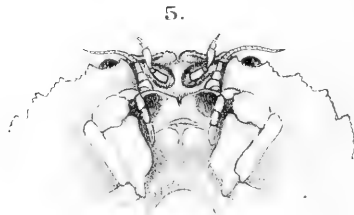
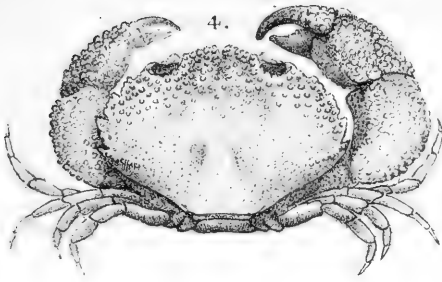
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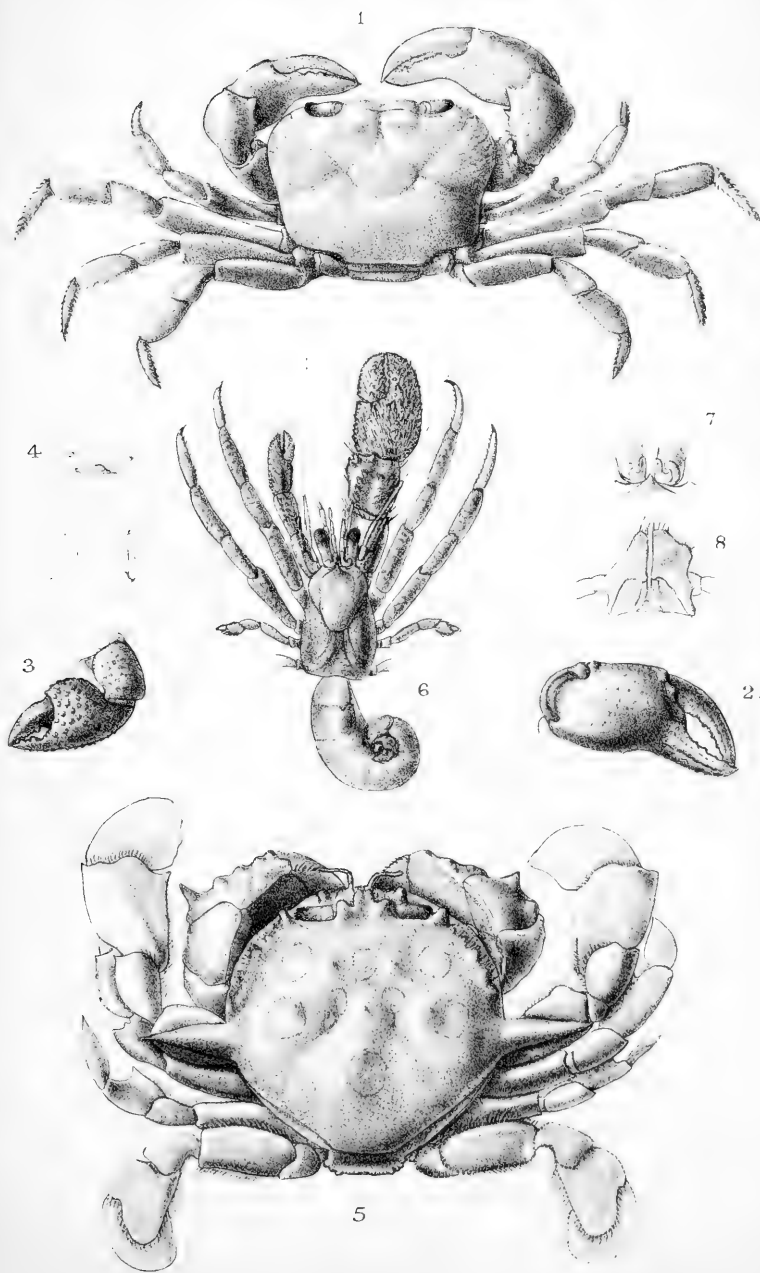




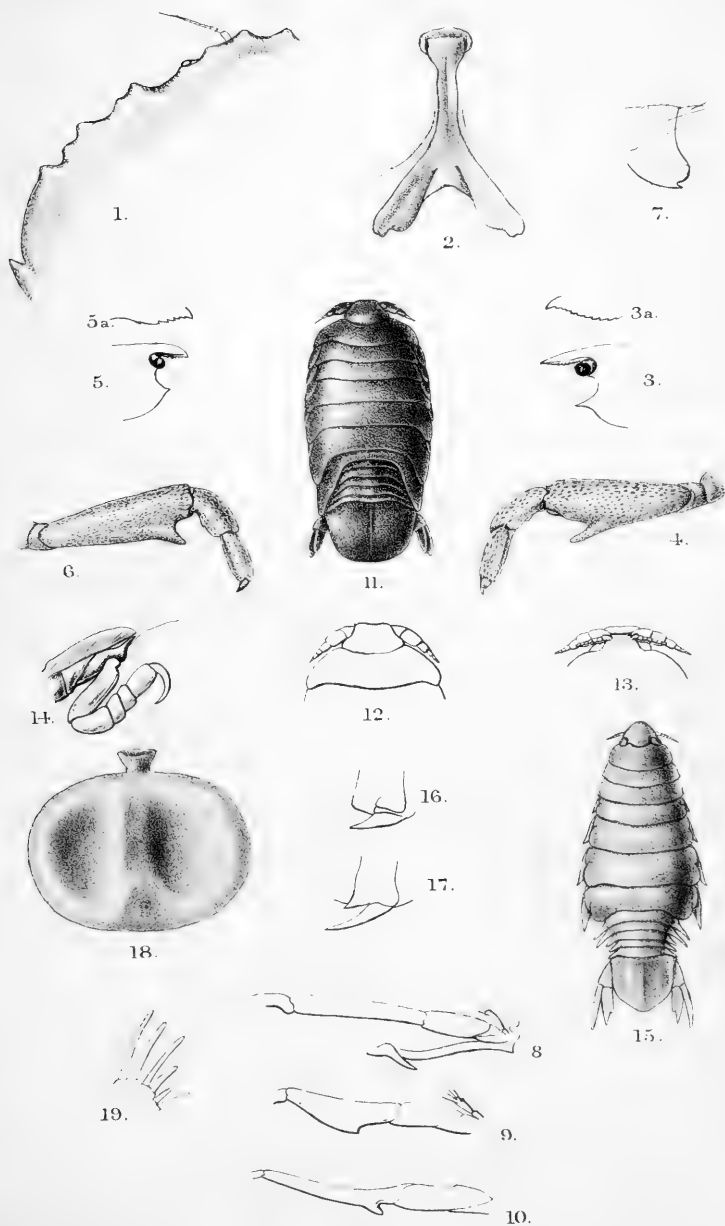








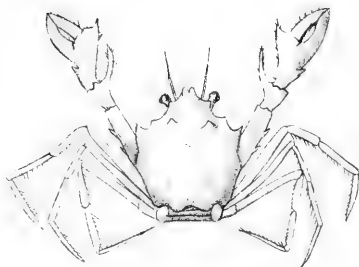








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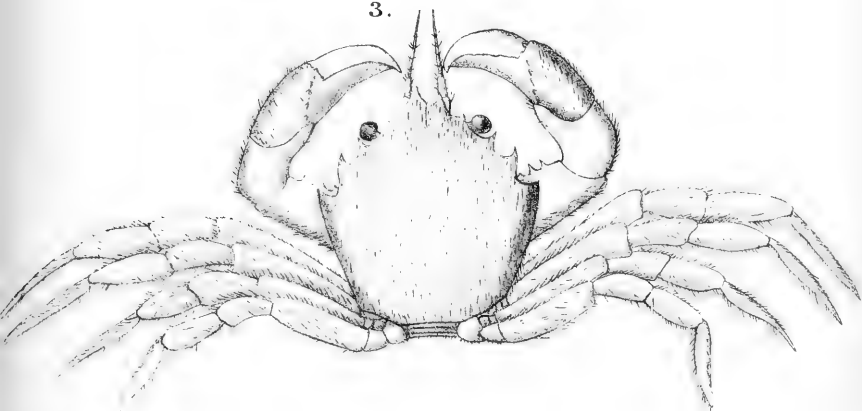
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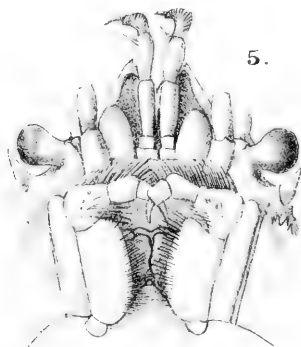
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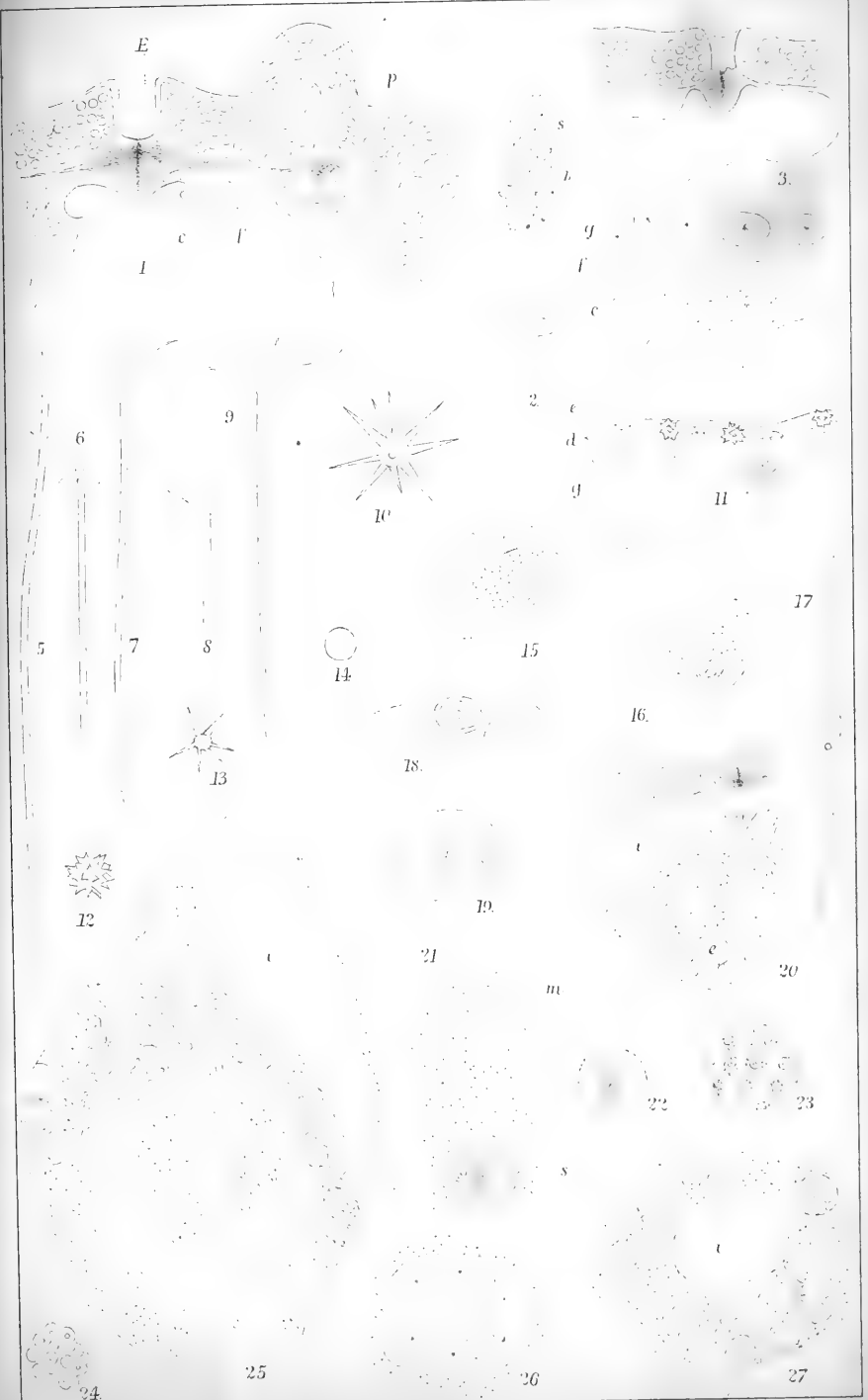
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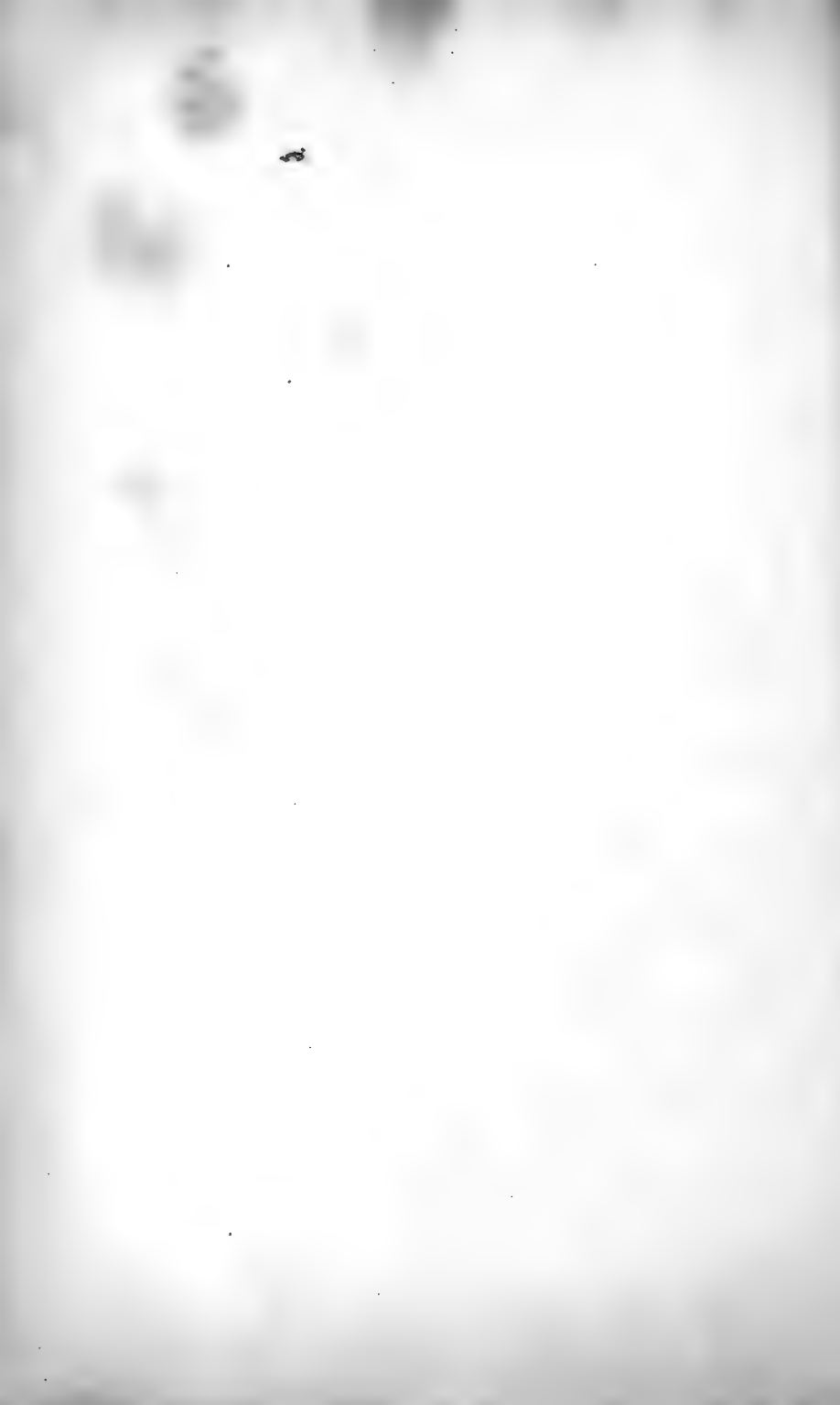


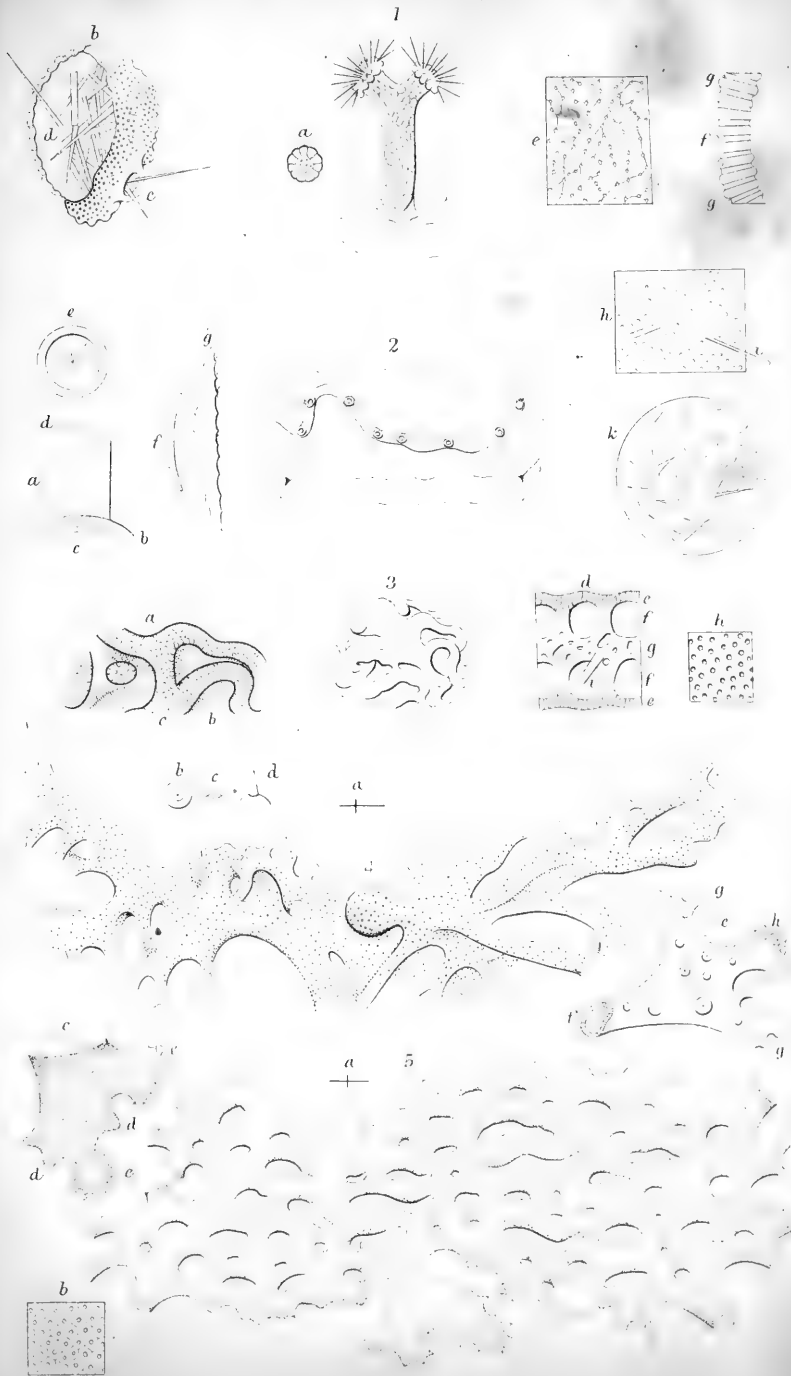
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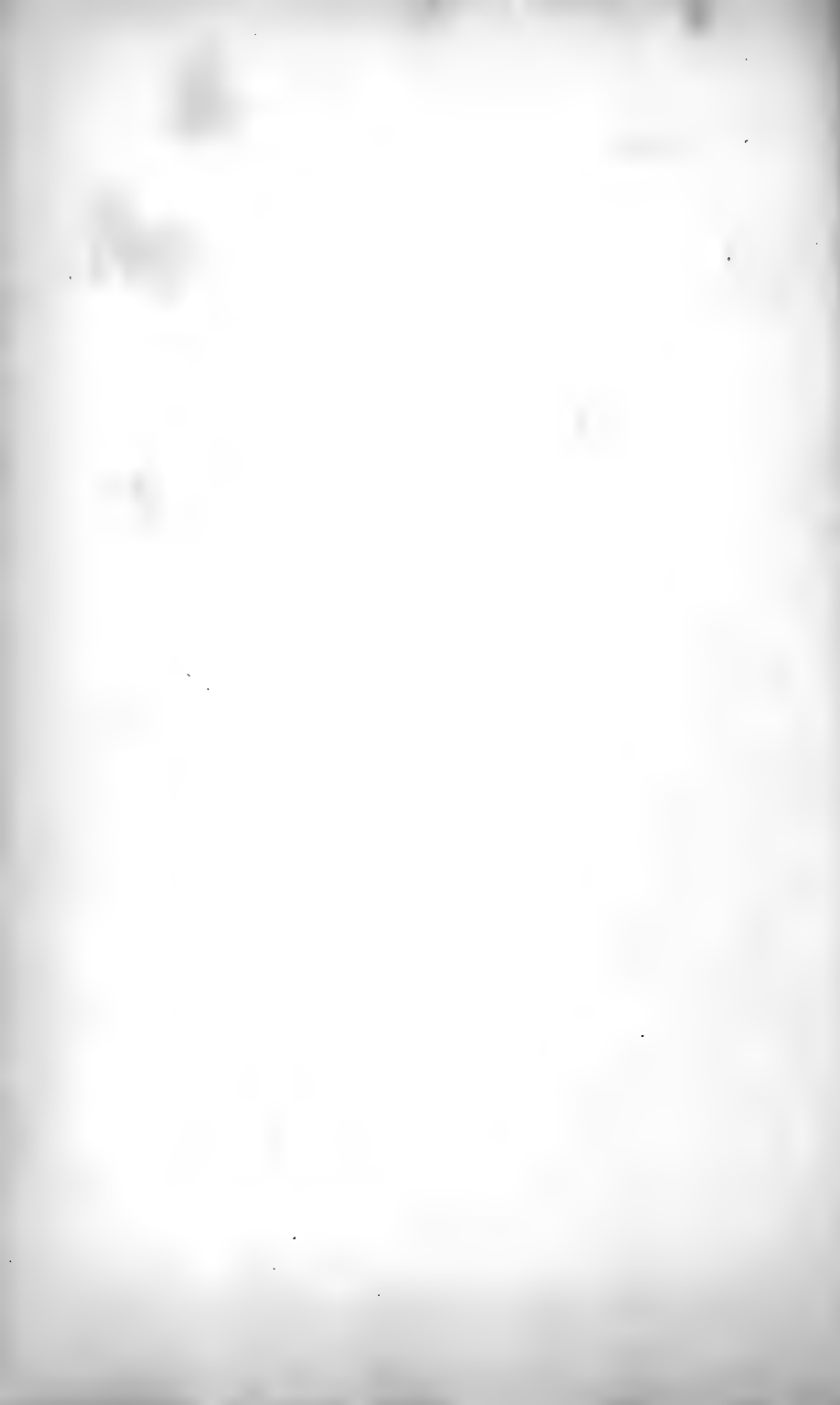






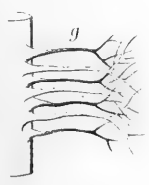
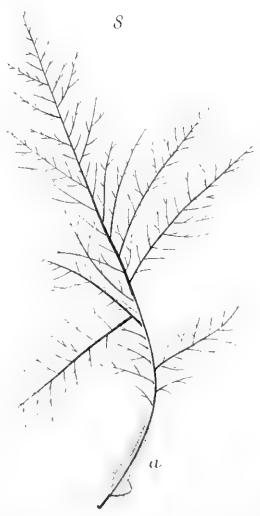
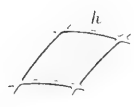






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